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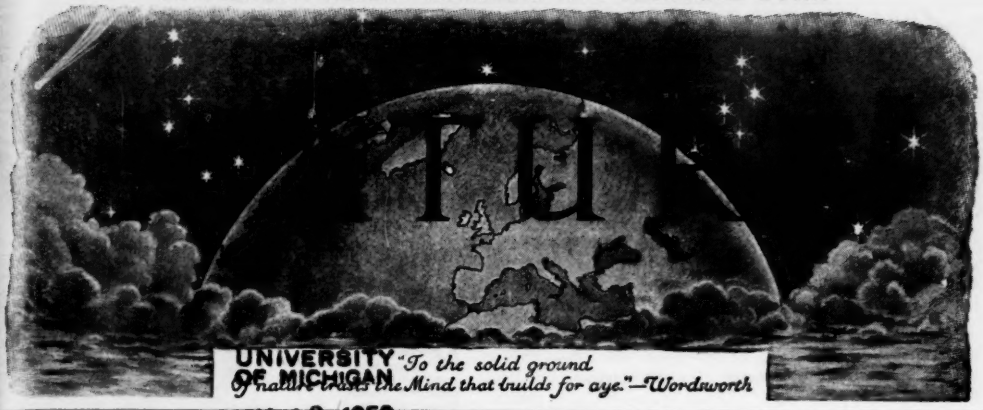

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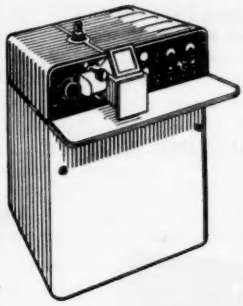

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SCIENTIFIC FREEDOM AND NATIONAL SECURITY

A SERIES of papers on the general theme "The Search for National Security" is published in the November 1951 issue of the *Annals of the American Academy of Political and Social Science*. These papers explore quite frankly the internal and external implications of the rearmament programme and the military aid programme in the United States, and recognize the importance of a moral basis for the effort to achieve security; but only one of them, that by Dr. E. A. Fitzpatrick on man-power and atomic war, appears to show any appreciation of the real difficulties that are involved in both the United States and elsewhere in the attempt to establish the security of the free Western world. Dr. Fitzpatrick is well aware of the importance of the man-power problem and of using wisely our limited resources of scientific, technical and other categories of man-power, if we are not to put on our national economy a strain that endangers it in another direction and may, if pushed too far, defeat our purpose. He recognizes, too, the unfortunate necessity of measures against subversion; but he nowhere indicates the real difficulty of devising secrecy measures which are effective without adverse results either on the recruitment of scientific workers and technologists of the highest quality, or on the creative work on which advance in science and technology depends.

Ultimately, security must be found in a dynamic and not in a static policy—in conditions which favour the most fruitful creative work—and it must always be a matter of nice judgment for the statesman where to draw the line and on which side it is wisest, from the point of view of national welfare and security, to run the calculated risk. No responsible man of science will deny the necessity for some secrecy measures, though he will insist that these should be limited to clearly defined fields, and applied in accordance with such principles as have well been set forth by Prof. W. Gellhorn, Prof. H. D. Lasswell and Mr. Alan Barth, and indeed earlier by Burke, Mill and Bagehot. Nor does it appear that the new measures announced by the British Government to ensure the reliability of atomic research workers and others employed on secret work go beyond what is reasonable. The inquiries to be made are administrative rather than formal, and the new questionnaire which came into use in the Civil Service on March 12 is to be completed only by staff employed on "exceptionally secret work, especially work involving access to secret information about atomic energy".

Much of this questionnaire consists of the routine inquiries which every Civil servant will have answered already, the new note being struck by the inquiries about membership of Communist or Fascist organizations, and visits abroad and foreign residence of more than six months, including a query regarding membership of any body associated in any way with the Communist or Fascist movements. In answering this question, the Civil servant is instructed to take account not merely of his own belief, but also of the

sort of opinion which is generally held of the body in question, even if he does not endorse that opinion; the value of this last injunction may well be questioned. But although there is some force in the contention of the Institution of Professional Civil Servants and other Civil Service unions that persons of disloyal intentions are unlikely to reveal themselves deliberately or inadvertently as a result of this inquiry, the purely negative attitude of the unions in their joint statement of protest is regrettable on public grounds and cannot claim general support from scientific men. Even if the fears of the Civil Service unions, that the procedure will put a premium on mischievous and malignant informers and create an atmosphere of suspicion between colleagues, can be substantiated—and no sound reasons are given to justify that contention—they can fairly be asked to suggest an alternative procedure. Their negative attitude ignores entirely the fact that no government can abrogate its responsibility for making formal inquiries of this type, even if it is left to the courts to deal with any subsequent charges of perjury or treason that may arise.

The formulation of constructive proposals for dealing with this issue is by no means easy, and is, in fact, scarcely possible without clear thought concerning principles to which Dr. H. A. Moe directed attention in a notable address, "The Power of Freedom", at the Johns Hopkins University Founders' Day last year. Dr. Moe's theme was that achievement is really the work of individuals, and that in a world which exalts organization it is necessary to insist that individuals, and individual persons only, are all that matter in the search to control our fates. Quoting Sir Henry Maine's generalization, "The progress of society is from status to contract", Dr. Moe pointed out that the essence of contract is the ability to make a choice of what one will or will not do. The greater the range of choice, the greater the rate of change, for change depends upon the possibilities that individual men see for the future.

This, Dr. Moe argued, is true in research, as in all human affairs; and accordingly all knowledge and understanding in the present depend on what individual men have had a chance to think and to do in the past. Knowledge and understanding are the outcome of the intellectual processes only of individuals. As John Livingston Lowes wrote in "The Road to Xanadu", "the imagination voyaging through chaos and reducing it to clarity and order is the symbol of all the quests which lend glory to our dust"; and to develop and bring to their highest possible exercise the capacities of individual persons to make that voyage is the world's greatest need. That voyage of imagination is what makes all scholarship and all art and all science creative and great, and to promote this capacity is the real goal of all universities and all learned foundations.

First, then, Dr. Moe suggests that universities and similar foundations should endeavour to provide opportunity for the ablest persons they can find to do what they themselves want to do. This means giving those who are contributing to the advancement of knowledge and understanding the utmost freedom for their creative work. Only in such conditions is work of that order possible. Moreover, we cannot tell the starting point of the next step in creative human developments, even if it were agreed that the next best step for mankind is in the understanding of man's relationship to man. Experience, indeed, teaches us that fields become sterile precisely when they become modish and accepted and dominated by professional or vested interests. Human advance is rather the record of man finding new problems, and then finding ways to solve them. No administrator or benefactor could have predicted some of the most startling discoveries in modern physics or in biology or biochemistry, or foreseen their effects on the world; and Dr. Moe declared that his philosophy of administration is to give able men the full opportunity to follow their bent. He stressed, too, that the administrator of funds to assist research and creative work should be able to recognize changes in value, to see men glimpsing new possibilities and new avenues for thought and expression, and should help them to pursue the gleam, and at the same time to give due weight to great traditions. The essential point is to make our institutions into strongholds of free enterprise in things of the mind and spirit, heeding Hans Zinsser's warning of the danger of the administrative 'camel' crowding the intellectual 'pilgrim' out of his 'tent'.

Dr. Moe reiterated his belief that only from the products of freedom of inquiry and creation can come the salvation of the world from the ills and doubts now besetting us, and that our first concern should be to see that the spirit of free inquiry and creation flourishes. He does not, indeed, expect government to do more than afford the time which the processes of education and creative thought require for their slow development, and he does not believe that the pressure for government research is ruining scholarship in the universities, though it could do so if carried to excess. Much government support of science is well administered, and he suggests that the criteria for the acceptance of government funds should be the national interest, remembering that the support of the potential path-finders should not be allowed to depend on any one source.

Of the secrecy issue Dr. Moe said nothing, neither accepting its necessity nor rejecting it outright. By implication he recognized its existence, and was worried about the ease with which "a few ignorant and irresponsible men can make conditions of governmental service, including the doing of research for the common good in the universities, all but unbearable for gifted and devoted men"; and in support of his affirmation that freedom is the propulsive power of American civilization, he quoted from T. H. Huxley's Founders' Day address to the same university seventy-five years earlier: "the future of the world lies in the hand of those who are able to carry the interpretation of nature a step further than their predecessors; . . . the highest function of a university is to seek out those men, cherish them, and give their ability to serve their kind full play".

There is thus much in this address of Dr. Moe's to support Dr. J. B. Conant's recent plea, both in his Stevenson Memorial Lecture at the London School of Economics and at the Pilgrim Trust luncheon the following day, for closer relations between the universities of the United States and the United Kingdom, and for co-operation between the two countries in working out a satisfactory balance between the demands of security and the demands of liberty on the body of scientific knowledge. Dr. Moe's address indicates the extent to which responsible opinion in the United States, though sometimes obscured by the dust raised by the proceedings under the 'loyalty programme', runs on similar lines to opinion in Great Britain. That impression is confirmed by the contributions to a symposium on "Scientists and Loyalty" in the December 1951 issue of the *Bulletin of the Atomic Scientists*. Beside an outspoken editorial on the effect of the loyalty investigations on scientific workers themselves, corroborating what Barth and Gellhorn reported in their recent books, and a factual examination by Prof. L. D. White of the 'loyalty programme' of the United States government, there are placed articles by Prof. A. V. Hill, Prof. N. F. Mott and Lord Boyd Orr, as well as by the American writers Dr. P. Morrison, of Cornell, and Mr. S. Levine, which were contributed to a symposium on the duty of the scientific man in society.

The similarity in thought and outlook between British men of science and their American colleagues is marked, and is equally apparent in the close analysis of the basis of national loyalty by M. Grodzius and the discussion of the responsibility of a university professor by Dr. S. K. Allison, also of Chicago, in the same *Bulletin*. It may be objected that Dr. Moe's address emphasizes rather the responsibility of the administrator, and the danger that the search for security and efficiency may demand so high a price that creative work and scientific advance are seriously checked. Nevertheless, in this Anglo–American discussion, while the responsibility of the man of science and the university to expound and defend the doctrine of freedom of thought and inquiry is just as firmly upheld, it is clearly recognized that there is also a price to be paid on the part of freedom in this present distracted and divided world.

The symposium, in fact, appears to accept, just as frankly as Dr. Conant, the need for some secrecy in a world of dangerous intellectual tension; though it does not bring out so incisively as he did the essentially new factor in the situation to-day. In the past, scientific knowledge has frequently been applied to the invention or improvement of weapons of war; but hitherto this has involved only a special application of principles already discovered through free scientific inquiry. The development of atomic weapons has for the first time subjected a large field of science to conditions of secrecy under the direct control of national governments. Nevertheless, the symposium pointed clearly to the value of Anglo–American co-operation in working out the most satisfactory measures for effecting the inescapable minimum of control, and avoiding so far as possible impediments to creative work and scientific advance in this and in other fields.

It could not be judged from this symposium how far the specific proposal for a joint commission of the two countries, or for some academic alliance between the universities of the United States and those of the English-speaking nations of the British Commonwealth, would command support. Even if formal co-operation founders on the obstacle that no nation is willing to enlarge its real or imagined security risk by divulging secrets of such transcendental importance even to its allies—particularly in view of the genuine opposition, apparent in this symposium, of so many scientific men to any restriction of the traditional freedom of publicity in science—something might well be accomplished informally. Dr. Conant's suggestions deserve to be explored fully. It is at least possible that out of them might come fresh creative thought about the whole situation; this might well resolve some of its practical difficulties and provide a means not merely of checking the abuse or unimaginative exercise of State power—with its consequent damage to science—but also of enlisting the loyal support of all scientific workers in the responsible as well as creative exercise of the great powers that lie in their hands.

Dr. Conant's proposal for a joint commission to weigh the balance between security and liberty has many very real practical merits. He pointed clearly to the real problems which require attention—those which arise in the conduct and relations of men of science, other academic men and government officials. It may well be true that the closer the framework within which such men work in one country approximates to that in another, the smoother the path of co-operation will be; and even if a joint commission such as Dr. Conant suggests finds that it can do its work best sitting behind heavily barred doors, the experiment might well be worth trying. Nor should it be written off as a failure if the outcome is an extension of informal rather than formal co-operation in this field, where common understanding is so vital to the free world.

THE GEOLOGY OF INDIA AND BURMA

A Manual of the Geology of India and Burma Compiled from the Observations of the Geological Survey of India and from Unofficial Sources, by H. B. Medlicott, W. T. Blanford, V. Ball and F. R. Mallet. Second edition, by R. D. Oldham. Third edition, revised and largely rewritten by Sir Edwin H. Pascoe. In four Vols. Vol. 1. Pp. xvi+483+20 plates. (Delhi: Manager of Publications, 1950.) n.p.

IN January of last year the Geological Survey of India celebrated the centenary of its foundation as a continuous organization, dating from the arrival in India, in March 1851, of Dr. Thomas Oldham. Oldham remained in charge of this Department until

his retirement from ill-health in 1876 after twenty-five years of service. He had planned the production for publication of a geological map of India and of a "Manual of the Geology" thereof to summarize this first period of the work of the Survey. But it fell to his successor as superintendent (designation later altered to director), H. B. Medlicott, in collaboration with Dr. W. T. Blanford, to write this "Manual", which was published in 1879 in two parts or volumes with a separate geological map on a scale of 1 inch/64 miles. (This was followed by Part 3, "Economic Geology", by V. Ball in 1881, and Part 4, "Mineralogy", by F. R. Mallet in 1887.) The arrangement in two volumes—(1) "Peninsular India"; (2) "Extra-Peninsular India"—really gives expression to the fact that India has been welded from the fragments of two quite distinct geological entities, namely: the fragment of Gondwanaland that constitutes the Peninsula of India and is almost devoid of marine fossiliferous formations; and the southern edge of Laurasia that overrides the northern edge of the Peninsula to form the Himalaya and other bordering mountains with their rich content of marine fossils.

The second edition of this "Manual" (that is, of Parts 1 and 2) was compiled by R. D. Oldham (Thomas Oldham's son) and published in 1893 in one volume. In this no attempt is made to maintain the distinction between Peninsular and Extra-Peninsular India, though some of the chapters had perforce to follow this plan. The accompanying geological map is on the scale of 1 inch/96 miles.

When Sir Edwin Pascoe retired from India in 1930, the preparation of another edition of this work was long overdue, and I was fortunately able to arrange with the Government of India to commission Sir Edwin to undertake this task, which, as it turned out, occupied the remainder of his life. At first it was planned to revert to two volumes, as with the first edition; but Sir Edwin soon found that, with the great increase in our knowledge of the geology of India resulting from the flux of time and the increases in the staff of the Department effected in turn by Sir Thomas Holland and Sir Henry Hayden, he required at least three volumes, and this was agreed to, with a final fourth volume for general and geographical indexes. Sir Edwin began his task in 1933, and finally submitted the manuscript of the three volumes by the end of 1939. The first volume was set up in type and the proofs thereof corrected by the author; but unfortunately the shortage of paper in India during the Second World War made it impossible to print this off, so that the type was distributed and melted for munitions purposes, and it was not until the end of 1945 that the press could again take up the work. The author had corrected the new proofs of Vol. 1, by then thoroughly revised, and of the galleys of Vol. 2, when he was taken ill with the malady that resulted in his death.

Thus Sir Edwin did not live to see the completion of his great work, which will long remain a testimony to his industry and scholarship over so many years. The benefits that he has thus conferred on Indian geology must be placed alongside those of Mr. T. H. D. La Touche in his successive volumes of the "Bibliography of Indian Geology", published between 1917 and 1923.

We must now welcome the publication of Vol. 1 of the third edition of the "Manual". It is dated 1950 and was issued at the end of that year, just in time for the centenary celebrations already mentioned. It is accompanied by a geological map on the scale of 1 inch/96 miles, the same as that of the map with the second edition.

"Burma" has been added to the title of the new edition, and the author states that the "country whose geological history this book endeavours to portray is that of the Indian Empire before the year 1937". (On April 1, 1937, Burma was separated from India.) This was also, of course, before the emergence of Pakistan as a separate political unit, which dates from August 15, 1947.

In deciding on the distribution of material between the three volumes, Sir Edwin has made no attempt to return to the distinction between Peninsular and Extra-Peninsular India, but has followed a strictly chronological plan. Vol. 1 is allotted to the Archæan and Purana formations; Vol. 2 to the Palæozoic (with Upper Purana) to Cretaceous formations; and Vol. 3 to the Deccan Trap and to the Tertiary and Recent. In making this division, Sir Edwin was faced with the necessity of deciding in which volume to place the Vindhyan system. Sir Thomas Holland, when he introduced the term "Purana"[1], placed the Vindhyans, with the Kurnools and their equivalents, in the upper section of the Purana group, equating the whole group approximately to the Algonkians of North America. In the absence of fossils, Holland was "unable, therefore, to say whether the younger stages of the Purana group were formed before Cambrian times or not; we can only assert that the Purana group, as a whole, is probably older than the Cambrian of Europe". Since Holland wrote, evidence of organic remains has been obtained from the Suket shales at the base of the Upper Vindhyans[2]. It seems from the above, however, that whether these are to be regarded as pre-Cambrian fossils, or as of Lower Cambrian age, Holland would still have placed the Vindhyans in his Purana group, owing to their association and mode of occurrence.

Pascoe realizes that Holland included the Vindhyans in his Purana group; but as he (Pascoe) has a bias towards regarding the Vindhyans as Lower Cambrian in spite of the absence of fossils, with the above exception, from rocks so eminently suitable for their preservation, he follows both the preceding editions of the "Manual" in regarding the Vindhyans as Lower Palæozoic, and accordingly uses the term 'Purana' in a variable manner, sometimes including the Vindhyan therein and sometimes not. This has resulted in the Vindhyans being relegated to the first chapter (14) of Vol. 2 under the title "Purana or Early Palæozoic". This decision is to be regretted, because the Vindhyans and their equivalents occur in the Peninsula below the great stratigraphical break marked by the Talchir boulder bed, so that Vol. 1 seems to come to a sudden and unnatural end, when the reader is expecting to see how the author treats the geological relationships of the Upper to the Lower Purana formations. However, this suspense will be ended when Vol. 2 appears.

Thus Vol. 1 consists mainly of a description of the Archæan formations (six chapters) and Lower Puranas (four chapters) relating chiefly to the geology of the Peninsula of India (Gondwanaland), with the fringes thereof appearing in the Outer Himalaya and elsewhere in Extra-Peninsular India. Considering that Sir Edwin, during the whole of his service prior to becoming director, never worked on the old rocks either of India or of Burma, Vol. 1 of his "Manual" must be regarded as a remarkable *tour de force*. For,

since the second edition was written, there has been a revolution in our knowledge of the old formations of the Peninsula, due partly to the wide use of the microscope in the study of the rocks and partly to the fact that several geologists have spent the major part of their working lives on a more detailed study of these formations than was attempted in the past. Besides officers of the Geological Survey of India (Middlemiss, Holland, T. L. Walker, Heron, Dunn, West, Krishnan and others), there has been the concentrated work of a number of geologists of the Mysore Geological Department (Smeeth, Jayaram, Sampat Iyengar, B. Rama Rao, Pichamuthu and others). Pascoe appears to have digested the whole of the vast corpus of their work, not excluding that of myself. Where we have often differed among ourselves in our interpretations, Pascoe has applied the acumen of an impartial judge. Where difference of opinion exists, he has stated both points of view and attempts to make a decision between the opposing views. These Archæan chapters must, indeed, be regarded as an entirely new work of the greatest value, as I am sure I shall find when I come to resume my "Attempt at the Correlation of the Ancient Schistose Formations of Peninsular India"[3]. In spite of my interest in the subject, any detailed discussion of this section of Pascoe's "Manual" would be out of place in this review.

In these Archæan chapters Sir Edwin enters into much greater detail than one might have expected, and this will probably be found also to be the case in the later volumes. But he explains this in his preface, dated January 27, 1939, by saying that "An attempt has been made to render it more a work of reference than a students' text-book, since the latter is available in the form of Mr. D. N. Wadia's excellent and well-known publication. An attempt to cater for the local geologist in India has played its part in swelling the volume of the work". Since that was written, another excellent work on the "Geology of India and Burma", by Dr. M. S. Krishnan, has appeared (1949), so that Sir Edwin's detailed treatment has become justified twice over. As a prelude to reading either of these text-books, the student might well be recommended to read the first two chapters of Pascoe's "Manual", in which with a master hand he discusses the physical geography and gives a summary of the geological history of India and Burma, as a prelude to the whole work.

The detail of Pascoe's "Manual" has necessitated the addition of several maps illustrating the geology of Rajputana, the Central Provinces, and the Simla Himalaya. It is a great pity that the geology of Singhbhum and adjoining tracts is not similarly illustrated, for I find this section of the work very difficult to follow without consulting official memoirs by Dunn and others, though I am generally familiar with the ground. In addition to the maps, the work contains some excellent photographs; but, alas, the typography is inferior, and in some copies the printing is indistinct, as if the type was not properly inked. There is also a considerable number of misprints. These blemishes are mentioned because it is a pity that so important a work should not have been well printed, and issued with a binding consonant with the quality of the contents.

L. L. Fermor

[1] *Trans. Min. Geol. Inst. Ind.*, **1**, 47 (1906).
[2] *Rec. Geol. Surv. Ind.*, **69**, 109 and 458 (1935).
[3] Mem. Geol. Surv. Ind., **70** (1936 and 1940).

CRYSTAL STRUCTURES OF INORGANIC COMPOUNDS

Crystal Structures

By Ralph W. G. Wyckoff. Vol. 2. Pp. ix+585. 10 dollars. First Supplement to Vol. 1. Pp. 136. 4 dollars. (New York and London: Interscience Publishers, Inc., 1951.)

THE appearance of the second volume of Dr. R. W. G. Wyckoff's "Crystal Structures" so soon after the first volume (see *Nature*, **163**, 622; 1949) is a remarkable testimony to the industry of the author. That he has been able to find the time, during his major work on electron microscopy, to continue his task of adding to the collection and classification of crystal-structure results must earn him the thanks of all who wish to have such records at their elbow.

As described in the review of the first volume, the form of presentation of the results is a novel one; in order to allow for periodic supplementation, the data are presented on loose-leaf sheets, which can be interleaved with fresh pages when necessary. Vol. 2 is, in fact, accompanied by a set of pages forming a supplement for Vol. 1. The complete set is to consist of three volumes, and fresh supplements are to be issued at intervals.

In the preface to Vol. 1 this form of presentation was frankly described as an experiment, and the two years that have now elapsed provide a basis for assessing whether the experiment is likely to be successful: if so, there are doubtless many other works which could be published in the same form; but, if not, others who may be contemplating similar ventures should be discouraged from them.

I have come to the reluctant conclusion that the experiment is not a happy one. The loose-leaf compilation tends after some time to become rather untidy; the pages become misaligned, and the holes tend to break through in pages that are referred to particularly frequently. Also, to allow for an appreciable number of new insertions, the spline is made much thicker than is required for the pages issued, and consequently packing the books with others on a bookshelf tends to break the binding. Some temporary packing might avoid this difficulty.

But these are only minor objections which would have little relevance if they did not interfere with the main purposes of the volumes—easy reference and continuity. In fact, the system suffers enormously from the fact that the contents, because of the nature of the presentation, cannot be indexed. Indeed, the books form their own indexes, but of a rather cumbersome kind; each chapter is divided into four sections—text, tables, bibliography, and figures—each of which has separate pagination. With practice, the reader should soon find himself able to locate, quickly and certainly, any information he requires.

The trouble is that practice *is* required. I have found that the system does not come naturally to me, and that, after some lapse of time of use of the volumes, the system has to be re-learned. This may be sheer conservatism on my part; but I turn instinctively to the "Strukturbericht" and the newer "Structure Reports", rather than face the complications of "Crystal Structures".

It is to be hoped therefore that, when the third volume is complete, the publishers will be able to

put the work into a more permanent form than the present; then simple indexes can be included and the whole work made much more useful to the average man of science who has become used to the ordinary ways of extracting information from the literature.

H. Lipson

LIFE AT A SUB-ANTARCTIC WEATHER STATION

Fourteen Men

The Story of the Australian Antarctic Expedition to Heard Island. By Arthur Scholes. Pp. xii+273+21 plates. (London: George Allen and Unwin, Ltd., 1951.) 15*s*. net.

NEARLY five years ago the Australian Government established scientific and meteorological stations on Heard and Macquarie Islands in the Southern Ocean, and these stations have been manned continuously since that time. Although Heard Island, which lies in lat. 53° 10′ S., long. 73° 35′ E., was first discovered by the British sealer Peter Kemp in 1833, and American sealers often wintered there in the third quarter of the nineteenth century, no scientific party had previously spent more than a few days on shore. Mr. Arthur Scholes was a member of the first party of fourteen Australian observers who landed in December 1947, and his book tells the story of their experiences on the Island until their relief by a second team in January 1949.

Mr. Scholes writes entirely as a journalist who has been taken at very short notice from his job in a newspaper office and transported some 2,500 miles through tempestuous seas to a practically unknown destination. Everything is strange to him, and he describes his adventures with a lively enthusiasm. Frankness is indeed the outstanding characteristic of his account, and the reader is made to feel that he is the writer's confidant throughout. Although the difficulties of setting a party and its stores ashore on a sub-antarctic island must not be under-rated, the description of the landing on Heard Island leaves the reader with the impression that the expedition was fortunate in accomplishing this part of the operation without mishap. There are few who will not agree with the exclamation of a member of the party that there must have been "Someone upstairs" looking after them at that time.

Of the fourteen men, three were meteorologists, two physicists, two surveyors, three radio operators; a medical officer, a geologist, an engineer and a cook made up the party. Life at the base, in which we are told that the cookhouse was the focus of all interests and a barometer of the party's morale, is well portrayed. Mr. Scholes was one of the radio operators and did not have the opportunity of accompanying the field parties which had the task of making a detailed survey of the Island. He does, however, succeed in giving the reader a good idea of the difficulties with which the surveyors were confronted. Faulty or inadequate equipment, inclement weather, with on an average one hurricane a week throughout the year, when the wind would often reach a recorded speed of 100 m.p.h., severely hampered field-work. Temperatures were never severe, even in mid-winter; but conditions of wet cold, with alternate periods of freeze and thaw, made all field-work unpleasant and even hazardous. For example, it was found that in a period of five days, a sleeping bag might increase as much as 8 lb. in weight by saturation, so that individual loads tended to become heavier rather than lighter with time spent in the field. Such conditions call for special equipment which is only now being developed. It is a credit to the spirit of the surveyors that a detailed map of Heard Island was completed.

Although the last chapter is entitled "The ship! The ship!" and ends with the departure of the fourteen men, it should not be forgotten that their successors on Heard Island are still carrying on the work.

J. D. M. Blyth

MEASUREMENTS OF MICROWAVE RADIATION

Micro-Wave Measurements

By Prof. H. M. Barlow and A. L. Cullen. Pp. xvi+400. (London: Constable and Co., Ltd., 1950.) 30*s*. net.

THE years 1940–50 saw a great development and expansion of the application of very short radio waves: new techniques were evolved which necessitated the investigation of new methods of measurement to establish the characteristics and performance of novel equipment. As is stated by the authors in the preface to this book: "Progress in the application of microwaves inevitably goes hand in hand with the development of the technique of measurement at the frequencies concerned. Improvements in efficiency and design of equipment demand more precise information about the conditions of its operation and the part played by its various components. Big strides forward have recently been made to meet this need, and although much remains to be done, a stage has now been reached at which a wide variety of measurements can be undertaken with reasonable accuracy".

The material presented in the book is primarily concerned with techniques of wide application, and particular attention has been given to principles of operation rather than to details of the apparatus itself.

After introductory chapters on the fundamentals of transmission and wave-guides, and the properties of cavity resonators, the authors proceed in Chapter 4 to a description of the measurement of wave-length and frequency. There then follows in the remaining eight chapters a discussion of the methods used in the measurement of voltage standing-wave ratio, power, attenuation, Q-factor, dielectric properties of materials, receiver and transmitter characteristics, and finally of several factors relating to the performance of microwave aerials. There are, in addition, five appendixes which extend the general theoretical treatment in the book to certain cases of specific interest, and which touch on such matters as the theory of wave-impedance transformation and Fourier analysis as applied to spectra.

This work is written in a clear style, is very well produced, and is liberally illustrated with clear line-diagrams. At the end of each chapter there is a useful list of references to original publications. The book should prove a useful guide to engineers concerned with the application of microwave techniques, and also to those using such techniques for research.

J. A. Saxton

The Electronic Engineering Master Index

A Subject Index to the Contents of Electronic and Allied Engineering Publications printed throughout the World from January through December 1949. Pp. xvi+296. (New York: Electronics Research Publishing Co., Inc., 1950.) 17.50 dollars.

THE 1949 edition of the "Electronic Engineering Master Index" is the fourth volume in a series covering the electronic and allied literature published throughout the world since 1925; it deals with material from nearly four hundred scientific magazines, journals and proceedings. The titles of all the articles appearing in foreign languages have been translated into English. In addition, a list is given of all the patents in this field granted in the United States during the period concerned, and there is a bibliography of books on subjects related to electronic engineering. The cumulative cross-index at the end of the book serves as a guide to the present volume as well as to all of the previous editions.

In view of the very large number of articles on electronic matters which appear yearly, this index will doubtless be found useful by many of those engaged in research and development work on such matters. J. A. S.

Finding Out about Atomic Energy

By J. L. Michiels. (Thrift Books, No. 6.) Pp. 124. (London: Watts and Co., Ltd., 1951.) 1*s*. net.

A Signpost to Mathematics

By Arthur Read. (Thrift Books, No. 8.) Pp. 123. (London: Watts and Co., Ltd., 1951.) 1*s*. net.

THREE of the first four volumes in the Thrift Books series (see *Nature*, **167**, 1004; 1951) dealt with biological topics. The next four, which have recently been issued, have a rather wider appeal. No. 5 deals with English literature, No. 7 with the history of the past three decades, No. 6 with atomic energy, and No. 8 with mathematics.

The author of "Finding Out about Atomic Energy", Dr. J. L. Michiels, is a nuclear physicist with considerable experience not only of the scientific aspect of his subject but also as a writer, and, as honorary general secretary of the Atomic Scientists Association, of the social, moral and political implications of atomic energy. Dr. Michiels concentrates upon giving the relevant scientific information which it is necessary for the non-scientist to have in order to appreciate the various political and social problems raised by the discovery of atomic fission. The historical development of the subject and details of experimental techniques are omitted. Nuclear reactors and nuclear power, radioisotopes, the fission bomb and the hydrogen bomb are discussed in some detail. The proper technical terms are introduced and used after clear definition, and the reader is led, somewhat rapidly perhaps, to understand what happens when nuclear energy is liberated and what the subsequent consequences may be. Possibly the lasting effects of nuclear radiation on human beings may be, with present knowledge, exaggerated, but they certainly should not be under-estimated. This is a good, semi-technical book for those who read to learn.

Mathematics in some form or another is used by almost everyone; but, nevertheless, the mathematician is still regarded by a large number of people with great respect and very often with awe, particularly so when the mathematician claims to be doing research in mathematics. It is to this awe-stricken section of the community that Mr. A. Read, lecturer in mathematics in the University of St. Andrews, addresses his remarks in "A Signpost to Mathematics". Whether or not he succeeds in making clear what prompts the mathematician to think of, and to juggle with, more and more abstruse problems is somewhat doubtful; but he has certainly written an interesting, stimulating and very readable book. S. WEINTROUB

Principles of Weed Control

By Prof. Gilbert H. Ahlgren, Prof. Glenn C. Klingman and Dale E. Wolf. Pp. vii+368. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1951.) 44*s*. net.

THIS book does for agriculture in the United States what G. H. Bates did for Great Britain in his book "Weed Control" (London: E. and F. N. Spon, Ltd., 1951; for *Farmer and Stockbreeder*). A brief historical summary is followed by an outline of the theoretical basis of weed control. The chapters on chemicals used in weed control demand a considerable knowledge of organic chemistry and plant physiology, but, granted this, the descriptions of chemical composition and properties of weed-killers are clear and are related to the uses of the substances and the precautions necessary in handling them.

The authors consider 2,4-D (2 : 4 di-chloro-phenoxy-acetic acid) to be the most useful herbicide available at present, and the properties, uses and methods of application of the substance in its various forms are dealt with at length. Nevertheless, a balance is preserved between traditional and modern methods of weed control, and throughout the book the authors emphasize that weed-killers should supplement, but not supplant, weed control by good management. The problems of weed control in different types of crop and in special habitats such as highway verges, timber yards and irrigation channels are considered, and the destruction of some of the more pernicious weeds is discussed in relation to their biology.

The principles of weed control are of universal application; but the practical details given here are for conditions in various parts of the United States. Weeds are referred to in the text by their American common names, but a list with the corresponding scientific names is given in the appendix. The references listed at the end of each chapter are almost entirely American, and this reduces the value of the book to readers outside the United States.

J. M. THURSTON

An Introduction to Psychology

By Gardner Murphy, with the assistance of Herbert Spohn. Pp. xix+583. (New York: Harper and Brothers; London: Hamish Hamilton, Ltd., 1951.) 4.25 dollars.

PROF. G. MURPHY has now provided the student of psychology with a new introductory text-book which differs from the usual kind in that it sets forth and interprets the facts in the context of the life of a person. In adopting this expository device, he follows in the 'personalistic' tradition of William Stern and G. W. Allport. The student is likely to find that such a treatment facilitates the assimilation of a wide range of material which might otherwise seem to lack coherence, and at the same time it brings the subject-matter of psychology near his own experience. Prof. Murphy knows how to present complex topics with a light touch, and his book is assured of the popularity won by his earlier text-books.

THE CAVENDISH LABORATORY ARCHIVES*

By Sir LAWRENCE BRAGG, O.B.E., F.R.S.

THE Cavendish Laboratory possesses remarkably complete records relating to the lives of three of the first four Cavendish professors. Mrs. Maxwell bequeathed to the Laboratory all her husband's letters and manuscripts. The collection includes Maxwell's letters both personal and scientific, the manuscripts of his books and scientific papers, his lecture notes as a student and the lecture notes he prepared for his courses, his experimental note-books, and the plans which he prepared when the Cavendish Laboratory was being built. Many items which Maxwell left in the Laboratory have been preserved. Since the Laboratory also has Maxwell's library, and the apparatus with which he carried out all his more important experimental work, the whole body of material constitutes a record of very great scientific interest. Quite recently Sir George Thomson and Mrs. Charnock have presented to the Cavendish Laboratory a large collection of their father's letters, manuscripts and note-books. This material has not yet been fully classified ; but it is already evident that it will be an invaluable supplement to the scientific apparatus and other material which has been preserved in the Laboratory where J. J. Thomson carried out all his scientific work.

Lady Rutherford presented all her husband's papers to the Cavendish Laboratory. It is a fascinating collection, because Lord Rutherford kept everything. He had an enormous scientific correspondence, and there are many long series of letters from men of science all over the world who were making fundamental discoveries in radioactivity. We have the manuscripts of his papers, books, and addresses. He kept books of newspaper cuttings. In addition, there are letters collected by Profs. A. S. Eve and N. Feather for the biographies of Rutherford which they wrote.

Much of this material has until recently been stored in the Cavendish without any attempt at review or classification. During the past eighteen months, it has fortunately been possible to arrange that Mr. Derek Price, who is a historian of science, should arrange it and make a list of what exists. He has unearthed many treasures, and I propose to give some examples here.

Maxwell, who was appointed in 1871, was the creator of the Cavendish Laboratory ; he planned its buildings and started its courses. He began his scientific career very early, for it is recorded by Glazebrook that his earliest papers to the Royal Society of Edinburgh were written when he was barely fifteen, and read to the Society by Prof. Forbes and Prof. Kelland because it was "not thought fit for a boy in a round jacket to mount the rostrum". We have one record of his early period, the minutes of a preliminary meeting of the "Physicomathematical Society" at the University of Edinburgh. A proposed set of rules and objects is drawn up. Maxwell mentions as an example the subjects he is prepared to talk about, and the minutes end, "N.B. No member shall be made to study any subject for which he has an unconquerable aversion".

* Substance of a Friday Evening Discourse at the Royal Institution delivered on March 28.

Maxwell's thesis for the Trinity Fellowship at Cambridge (1855) was a mathematical treatment of Faraday's lines of force. Perhaps this was the origin of a letter from Faraday to Maxwell dated 1857, when Faraday was sixty-six and Maxwell only twenty-six. It is a delightfully courteous letter from the great man to the young beginner, and the part quoted here has not lost its interest with time :

"There is one thing I would be glad to ask you. When a mathematician engaged in investigating physical actions and results has arrived at his conclusions, may they not be expressed in common language as fully, clearly, and definitely as in mathematical formulæ ? If so, would it not be a great boon to such as I to express them so ?—translating them out of their hieroglyphics, that we might also work upon them by experiment. I think it must be so, because I have always found that you could convey to me a perfectly clear picture of your conclusions ; which, though they may give me no full understanding of the steps of your process, give me the results neither above nor below the truth ; and so clear in character that I can think and work from them. If this be possible would it not be a good thing if mathematicians working on these subjects were to give us the results in this popular, useful, working state, as well as that which is their own and proper to them.

Ever My Dear Sir,
Most truly yours,
M. Faraday".

Another note of Maxwell's is headed "Concerning Demons" and starts "Who gave them this name ? Thomson". All lecturers on thermodynamics quote 'Maxwell's Demons', who can defeat the second law by opening a door when a fast molecule approaches and closing it against a slow one. Apparently Kelvin was actually their parent.

Maxwell and Tait were indefatigable correspondents. They had been school-fellows at the Edinburgh Academy. The postcards and letters which they interchanged were a running commentary on scientific events of the day, largely in a kind of punning mathematical shorthand which they had invented. Some two hundred of these are among the Maxwell papers. One, clearly referring to a lecture Tait is to give at the Cavendish, starts "O T′, θαγξ φορ Αλλες;" and goes on to say that Prof. Liveing will provide the lime-light, the gases will go for half an hour, and that if he is particular about his lantern he had better bring his own like Guy Fawkes or the Man in the Moon. . . . "Yr's $\delta p/\delta t$" (T′ = Tait, $\delta p/\delta t$ = J. C. Maxwell).

The Cambridge period is initiated by the letter inviting him to be a candidate for the Cavendish chair at a salary of £500 a year, and encouraging him by an assurance that Kelvin did not wish to be considered. A great contribution which Maxwell made was the design of a laboratory for physical investigations which is recognizably of a modern type. The idea of such a laboratory was quite new in Britain ; when at King's College, for example, Maxwell carried out his experiments in the garret of

his home. Maxwell's note-book at that period contains references to details of the building which have quite a modern ring; care that the lecture-room can be quickly darkened by shutters, positions of taps and leads on the lecture bench, and facilities for showing diagrams. The rooms were definitely planned for different types of experiment. An interesting relic which came to light recently in a drawer of an old desk is a small screw of paper which had apparently been overlooked in tidying operations; it had on it the names of "Gentlemen at Practical Work, Lent Term, 1877", including Schuster, Shaw (Sir Napier Shaw), Glazebrook, Fenton, McAllister. Another interesting letter is one to Maxwell from Stokes about one of Maxwell's papers submitted for publication by the Royal Society. It is dated 1878, and is typewritten! Stokes had the first typewriter in Cambridge, and remarks in his letter that he is going to London to get a new ribbon for it, as the old one is worn out.

Rayleigh was elected to succeed Maxwell in 1879 and took up his duties in the Lent term, 1880. The Laboratory has some of the apparatus with which he carried out his classical researches into the value of the electrical units, but has none of his letters and papers. The present Lord Rayleigh has made it possible for us to examine the collection of documents at Terling Place, and it is hoped to get copies of such as are relevant to Rayleigh's tenure of the Cavendish chair. He resigned in 1884. One very interesting letter was written by Schuster to Rayleigh, evidently in reply to a question about the best way of organizing elementary and advanced experimental work at Cambridge. It contains many practical suggestions and includes the prophecy, "The future of the Cavendish Laboratory will however much more depend on a more advanced class of workers who no doubt will almost exclusively be graduates. No place ought to produce more men of their class than Cambridge".

The collection of J. J. Thomson letters has so recently been acquired by the Laboratory that no attempt can be made to summarize them here. One very interesting series contains the letters written to Threlfall in New Zealand between 1886 and 1896. The letters gain in interest because Threlfall was at the antipodes and 'J. J.' was taking pains to keep him abreast of all the recent news. There is a letter about a fight in Cambridge concerning women's status in the University. Another has a reference to the work of Rayleigh which led to the discovery of the inert gases: "Rayleigh has been working at nitrogen for some time and finds very decided differences in the densities according to the method by which it has been prepared. If he prepares it from air he finds that it is heavier than if he prepares it from NH_3 by burning up the H. He is inclined to think that when nitrogen is prepared from a compound such as NH_3 in which only one atom of nitrogen is present in the molecule, the result is that instead of a uniform gas each of whose molecules consists of two atoms of N, a mixture of N_2 and N is produced. It is singular if this is the case that the mixture should be able to preserve its constitution unaltered after being passed through red hot tubes, strong alkalis and acids, etc. as Rayleigh finds is the case . . .". He excuses himself for cutting short a scientific disquisition by saying, "I am to be married to-morrow to Miss Rose Paget". A letter marking a turning point in the history of science begins, "Dear Sir—I shall be very glad for you to work at the Cavendish Laboratory . . ." and ends "Believe me, Yours very truly, J. J. Thomson. To E. Rutherford, Esq.". This letter, and another series linking the two men, comes from the Rutherford collection. The latter series consists of letters passing between them, and an agreement finally signed by both, which defines their relative spheres of influence in the Cavendish Laboratory when Rutherford was contemplating being a candidate for the chair vacated by J. J. Thomson in 1919. Rutherford will not consider this step should it in any way disturb his old friendship with 'J. J.'; the latter assures Rutherford that he will have as free a hand in the running of the Laboratory as if he (J. J.) were in a separate building, and only wants a small enclave set aside for his own researches.

The Rutherford collection is so complete that it is impossible even to indicate its extent here, and I must content myself with two examples of its treasures. The first is several sheets of MS. clipped together and headed "Theory of structure of atom", and beginning "Suppose atom consists of + charge ne at centre and − charge as electrons distributed throughout sphere of radius b". It would appear actually to be his original speculation about the nucleus, if only because so much of it consists of unnecessary complications which could later be discarded.

The other example is taken from the remarkable collection of letters from colleagues about radioactivity. One file contains the letters written by my father to Rutherford between the years 1904 and 1909. In 1904 my father was at the University of Adelaide. He had had a very full and busy life organizing his department, and indeed much of the University, and it was not until the age of forty-two that he attempted to do any original research. He was asked to read a paper on radioactivity to the Australian Association for the Advancement of Science. This aroused his interest in α-rays, and he purchased some radium bromide and made experiments on the variation of ionizing power along the path of the α-particles. He was able to prove that all α-particles from each type of radioactive atom have a definite energy, that they go through gas or solid without deviation, and have a definite range. He had no colleague in Australia with whom he could discuss his results; they are set out in a series of long letters to Rutherford at McGill in Montreal. The first letter starts, "I have lately obtained some curious experimental results in connection with the absorption of the α rays which are, I think, new". In the second letter he has had a reply, and is thrilled to know that Rutherford thinks the ideas are new and really important. Later letters deal with γ-rays and X-rays. My father was discovering some of the fundamental phenomena which are now explained by the quantum theory, but which at the time seemed inexplicable on any electromagnetic theory of the nature of these radiations. He was led to his 'neutral-pair' theory by his correct deduction that the rays produced their effects at points in space, and conveyed momentum to the electrons they hit. The neutral-pair theory was wrong, but the interpretation of the experimental data was right; the ideas were finally reconciled by Laue's discovery of the diffraction of X-rays and our work together with the X-ray spectrometer. The long letters came to an end when my father came to Leeds in 1909, because he then frequently met Rutherford, who was by that time in Manchester. They constitute, however, a complete

and intimate history of my father's great research work on α-rays, for which he first became famous. These letters are only some thirty in all in a collection of several thousand from scientists all over the world.

The Cavendish collection must surely be unique as a record of the progress in physics during the past hundred years. Most of the great physicists in the Commonwealth have at some time worked in the Cavendish, and by good fortune the letters, notes and manuscripts relating to their work have been preserved in this very complete form.

THE TOTAL SOLAR ECLIPSE OF FEBRUARY 25, 1952

By Prof. R. O. REDMAN, F.R.S.
The Observatories, University of Cambridge

An account of the plans to observe the total solar eclipse of February 25, 1952, has already been given in these pages[1]. About sixty astronomers and technicians, nearly all from Europe and the United States, were concentrated in the Sudan, and were favoured with fine weather. A few geodetic observers in Kuwait and Iraq were frustrated by cloud. It is probable that there were also parties in the field in south-east Russia and southern Siberia, but so far no reports have been received of their plans or their achievements. The full results of the work attempted are unlikely to be available for two or three years, as the ratio of measuring-time to exposure-time is often extremely high for eclipse photographs, so that the following account must be taken only as a general preliminary indication of what was done.

Using the standard meteorological records for February and March, the chances of a clear sky in the Sudan appeared to be about 95 per cent, a much more favourable figure than most eclipse tracks offer, and it was chiefly for this reason that so many astronomers decided to observe this particular eclipse. Most of them chose to go to the neighbourhood of Khartoum because it is easily accessible, has good living accommodation, and offered a reasonable amount of other facilities. Experience there during January and February suggested, however, that the weather prospects had been over-rated. An ordinary sunshine recorder can show an unbroken trace even when the sky would be considered quite bad for observations of the corona, for example, on account of cirrus cloud or dust haze, and there seemed, in fact, to be a rather large number of such imperfect days. Ultimately the chances were revised to 50 per cent good clear sky, 5 per cent too bad for any optical observations, and 45 per cent of quality varying between these extremes. During the weeks of preparation, all observers were troubled to some extent by heat and dust, although there was no really bad 'haboob'. The daily maximum shade temperature varied between 28° and 41° C., the average diurnal range being about 17° C.; the humidity was extremely low. The day of the eclipse was cool, and the sky almost completely clear, although not perfectly transparent. A fresh northerly breeze died down somewhat during the onset of the eclipse, but remained sufficient during totality to cause troublesome vibration of instruments in a few cases. The seeing was otherwise remarkably good, with little scintillation. The shadow bands were inconspicuous, and noticed only by a few observers.

A very wide range of equipment was used and the time allowed for preparation on site showed a rather surprising amount of variation as well. A few cautious observers arrived at the beginning of the year, allowing themselves about eight weeks before the eclipse; the majority came in the second half of January and had five or six weeks; one group reached Khartoum with only seven days in hand. The experience of the British–Dutch party, with which I was associated, was that about four weeks on the site were sufficient for fairly simple apparatus, but that the five weeks which before the War were usually regarded as a safe allowance are inadequate for the larger and more elaborate instruments now coming into use, especially if these require not merely erection and adjustment, but also supplementary observations in the days before and after totality, for photometric and other calibrations. In such cases seven or eight weeks are not excessive for preparation on site.

This was the first eclipse with a clear sky at which a good number of both optical and radio observers were working practically side by side. Observations of solar radio noise were undertaken by two groups: an American party from the Naval Research Laboratory, Washington, led by Dr. J. P. Hagen, made observations in two wave-length bands at 8·5 mm. and 10·6 cm. respectively, while a French party from the Institut d'Astrophysique, Paris, under Dr. M. Laffineur, worked at wave-lengths 55 cm. and 117 cm. The sun was 'quiet', and it is understood that both groups obtained satisfactory records, although the details are not yet generally known. The measures should help considerably in the location of the solar levels from which the radio noise comes, and the evaluation of the physical conditions at these levels. A particularly interesting question is that of the kinetic temperature of the chromosphere, where at present there is a conflict of data. Measures at 8·5 mm. should refer to the upper chromosphere, somewhat less than 10,000 km. above the photosphere, and earlier radio results have pointed to a temperature not far from that of the photosphere itself. On the other hand, the only reasonably accurate optical measures of chromospheric line-widths available until now suggest a considerably higher temperature. In the hope of improving these, I obtained photographs of the chromospheric spectrum in two regions, λλ5550–6040 A. at second contact, and λλ3430–4110 A. at third contact, using the second order of a 6-in. concave grating in a Wadsworth mounting. The spectrograph was in a pit in the ground for thermal insulation; it was used as an ordinary laboratory slit instrument, and gave a dispersion about 2¼ A./mm. The photographs appear to be satisfactory, but critical examination and discussion will take many months. An alternative approach to the line-width question was followed by Prof. H. Brück and Dr. D. A. Jackson (Dublin), who used a Fabry-Perot interferometer in combination with a standard Hilger quartz spectrograph. In view of the great technical difficulties, the complexity of the chromospheric spectrum, the brevity of the allowed time of exposure, and the difficulty of maintaining the adjustment of an interferometer outdoors, in a climate with grilling sunshine and a very high diurnal range of temperature, this work must be classed as a bold enterprise. Nevertheless, a first

examination of the exposures indicates success. The problem of interpreting the fringe patterns promises to be complicated, but the results should be of great interest.

The long-standing problem of the distribution of line emission with height in the chromosphere was tackled very thoroughly by two parties. Dr. J. Houtgast and Mr. C. Zwaan (Utrecht), using objective prisms, obtained a fine series of spectrograms at both second and third contacts. They calibrated these very carefully, so as to permit not only reliable measures of the distribution of intensity with regard to height, but also measures of the absolute brightness of the chromosphere in any selected line of its spectrum. A programme closely similar in principle, although very different in practical detail, was followed by Dr. John W. Evans (High Altitude Observatory, Colorado) and his associates. They also used slitless spectrographs, with three gratings covering a wide range of spectrum from ultra-violet to infra-red, and with (for an eclipse instrument) elaborate control gear for making exposures, changing the films, etc. It is understood that much valuable material was collected, although not enough is known of the results for comment to be made here.

There was a great concentration on problems relating to the corona. Regular daily observations with coronagraphs at mountain stations have added much to our knowledge of the lower corona during the past ten years; but far from supplanting eclipse observations, they have served rather to stimulate eclipse work, and incidentally to encourage a breakaway from the unimaginative eclipse routines of the past. Prof. M. Waldmeier (Zurich) led a large Swiss party of about a dozen observers, operating a considerable number of instruments, nearly all devoted to the corona. The underlying thought of this programme was that the corona must now be regarded as variable in some—perhaps most—of its physical characteristics, so that the validity of combining data from different observers at different eclipses may be questioned. The aim, then, was to make simultaneously as many different observations as possible, to get an accurate and comprehensive picture of the corona as it was at one particular moment, employing the usual techniques of photometry, polarimetry, spectroscopy, etc. Prof. Waldmeier has described his results as excellent.

Coronagraphs operating in full daylight are able to observe only the inner corona, and owing to the increase of scattering in the earth's atmosphere, their efficiency falls off with decreasing wave-lengths. Eclipse programmes to-day tend therefore either to an examination of the low corona with the view of testing the reliability of coronagraph results, or to observation particularly of those features inaccessible to the coronagraph. With this second purpose in mind, the spectrum of the inner corona was examined down to the atmospheric limit in the ultra-violet by the late Dr. B. Lyot (Paris), using a spectrograph with two semicircular slits, covering between them much of the field around the sun. Other French observers, from the Institut d'Astrophysique (MM. Pecker, Michard, Dollfus, Mme. d'Azambuja) directed their attention to the outer corona, attempting to obtain its spectrum, and also to photograph it through polarizing screens in red and in infra-red light, as far out as possible. They also photographed the corona with a Lyot filter, in light from its green and red emission lines respectively. All these observers obtained a considerable measure of success, some of their material being outstandingly good.

Two important new methods of observation were tried out for the first time. Dr. I. H. Abd-El-Rahman (Helwan) scanned the outer corona, using a photomultiplier as light receiver, with the intention of measuring the light distribution with regard to position angle around the sun, and of obtaining also a measure of the polarization. His apparatus gave about half of the observations he had hoped to get, a commendable result for a new and hitherto untried instrument. Dr. D. E. Blackwell (Cambridge) measured the relative brightness of the corona in the infra-red at a wave-length about $2\,\mu$ and in the violet at about $0{\cdot}4\,\mu$, using respectively a lead sulphide cell and a photomultiplier as receivers. He succeeded in obtaining satisfactory readings at a number of points out to a distance about $3{\cdot}5$ radii from the limb, and will be able to extract valuable information about the relative importance of the *K*- and *F*-coronas.

Photographic photometry of the corona in polarized light was tackled in a very thorough manner by Dr. H. von Klüber (Cambridge), and an excellent series of photographs was obtained. The inner corona was photographed on a large scale, again for surface photometry, by Dr. F. Haddock (Washington) and by Prof. M. R. Madwar (Helwan). Prominence spectra were photographed successfully by both Prof. H. Zanstra (Amsterdam) and Dr. G. Righini (Arcetri-Florence). Prof. G. van Biesbroeck (Yerkes) photographed the star field around the sun, for measurement of the Einstein shift, with a new arrangement to allow a comparison star field to be photographed simultaneously.

This article is not a complete record of all those who observed the eclipse; but two other parties must be mentioned, namely, a large group sponsored by the U.S. Air Force, under the leadership of Dr. F. J. Heyden, *S.J.* (Georgetown, D.C.), and the other a smaller group from the Royal Greenwich Observatory, under Dr. R. d'E. Atkinson. These had geodesy rather than astrophysics in mind, being engaged in precise measurement of relative positions on the earth's surface by accurate observation of the local circumstances of the eclipse. The American observers, distributed in small groups from the west coast of Africa (Libreville) right across the continent and on into Saudi Arabia, used photoelectric equipment for measuring the light from the sun in the partial phases near totality. The Greenwich observers at two stations in the Sudan and two in Kuwait and Iraq respectively, in each case near the edge of the totality belt, took cine-photographs of the crescent of the sun near totality, following the same method as was successfully used in Kenya in 1947. Clouds in Iraq and a certain amount of instrumental trouble in the Sudan hampered their work, but partial success was nevertheless attained. The American results are not yet available. The photometric method seems likely to be less accurate than the direct geometrical approach, but has the advantage of giving results even in a cloudy sky.

All expeditions in the Sudan had reason to be grateful for help received from several departments of the Sudan Government. Special mention should be made of the Civil Secretary's Office, where Mr. H. Colville-Stewart acted as an extremely efficient liaison officer, of whose services all eclipse parties made great use. The British Army and the R.A.F. acted as host to several parties, and gave a considerable

amount of material assistance as well. A good deal of helpful interest was shown also by the staff of Gordon College and by private residents in Khartoum.

To an observer with some experience of pre-war eclipse expeditions from Great Britain, remarkable features of the recent eclipse were the growth in size and elaboration of the instruments used, and the lavish scale of expenditure of some expeditions. As everyone who tries it soon discovers, to make a scientific instrument work well in the open air, exactly at a given time, under conditions which cannot be reproduced beforehand, and perhaps in an extreme climate too, is far more difficult than to use it in an ordinary laboratory. Increased complexity of eclipse instruments seems inevitable, as problems and techniques develop, and in consequence the demands upon eclipse observers can now be sometimes rather severe. One result, already apparent, is that the ratio of observers to instruments, sometimes less than unity before the War, is tending to increase to two or three or more, while, as already noticed, the time allowed for preparation on site is tending to get longer.

The other point is of more local significance. British expeditions are at present financed chiefly by Government grants from the Royal Society, made on the recommendation of the Joint Permanent Eclipse Committee of the Royal Society and the Royal Astronomical Society. These grants are very limited in amount and are quite inadequate when more than one expedition is proposed. It is no longer possible to look to private individuals for subsidies, while British universities in general have no funds from which any appreciable contribution can be made. At the recent eclipse the Greenwich parties were paid for by the Admiralty, but even with this included, British expenditure amounted to only about one per cent of the reputed American expenditure. The Joint Permanent Eclipse Committee does excellent work within its means, and it is not necessary that British eclipse funds should be increased a hundred-fold—nor indeed is it likely that with such an increase the results would be related linearly to expenditure—but it is suggested that some means should be found of financing eclipse expeditions from Great Britain more liberally, especially now that radio astronomers are in the field as well as the traditional optical observers.

[1] Stratton, F. J. M., *Nature*, **169**, 259 (1952).

SANTIAGO RAMÓN Y CAJAL (1852–1934)

PROBABLY the greatest neurohistologist of his generation, Santiago Ramón y Cajal, son of a surgeon, was born in Petilla de Aragon a century ago, on May 1, 1852. After obtaining from the University of Zaragoza at the age of twenty-one a licence to practise medicine, he saw military service with the army medical corps in Cuba. In 1879 he was appointed director of the medical museum at Zaragoza, in 1883 professor of anatomy at Valencia, and in 1887 professor of histology and pathological anatomy at Barcelona. Five years later he was called to the corresponding chair at Madrid, from which he retired in 1922. For many years he was in charge of the Madrid Institute, which bears his name. His "Trabajos del Laboratorio de Investigaciones biológicas de la Universitad de Madrid" was influential in making known to the world the work of Spanish men of science.

In 1889 Ramón y Cajal improved Golgi's chrome-silver stain, which he applied to the whole nervous system and which led to his doctrine of the neurones. Using a photographic technique, he showed that all nerve cells are discrete units and that the cells of the grey matter are not organized as a network, as had previously been assumed. His name has become attached to some six staining methods, to the olfactory area, to the commissural nucleus, and to the horizontal cells of the cortex. Among his other classic contributions to neurology may be mentioned his discovery of the optic chiasma and of the innervation of the retina; his elucidation of the histology of degeneration and regeneration of nerve tissue; his modernization of the study of gliomata; and his pioneer use of colour photography. Shortly before his death on October 17, 1934, Ramón y Cajal reviewed and re-edited his first work on the neurone. He supervised the translation of his most important books, and his "Histology of the Nervous System in Man and Vertebrates" remains to this day the most complete and accurate account of the microscopic anatomy of the nervous system.

Ramón y Cajal's interests were wide. He was a talented artist, and his extra-professional writings, such as his "Charlas de café" (1920), reflect his philosophic bent, his humanity, and his Latin pessimism. He sought no honours, but regarded his election as a foreign member of the Royal Society of London and his Nobel Prize for Medicine and Physiology, which he shared with Golgi in 1906, as a tribute to Spanish scientific research.

A long obituary notice of Ramón y Cajal appeared in *Nature* of December 8, 1934, p. 871, contributed by "C. S. S.", initials which are easily recognized as being those of one of the 'immortals' of physiology who himself died but a short time ago.

OBITUARIES

Sir Charles Sherrington, O.M., G.B.E., F.R.S.

Sir Charles Sherrington, formerly Waynflete professor of physiology in the University of Oxford, and president during 1920–25 of the Royal Society, died on March 4 at the age of ninety-four. Among his many distinctions may be mentioned the Copley Medal (1927) and a Royal Medal (1905) of the Royal Society and the Nobel Prize for Medicine and Physiology in 1932 (with Prof. E. D. Adrian); he was an honorary or foreign member of many learned societies throughout the world.

We print below some appreciations which we have received.

More than forty years ago Sherrington published the Silliman Lectures he had given at Yale under the title "The Integrative Action of the Nervous System", and if he had published nothing after this he would still deserve to be reckoned one of the great physiologists. He gave us a new outlook on the nervous system by analysing its operations into their simplest elements and showing how these elements are welded together. The spinal reflex is taken as the starting point, and as Sherrington's chapters succeed one another the mechanism of sense organs and nerve

fibres and central connexions is gradually transformed into a living organization responsible for the most elaborate behaviour of the individual. His book is the more compelling because Sherrington's singular genius is stamped on every page of it—his tricks of prose, his epigrammatic constructions and his pregnant imagery. He has so much to tell us that he cannot be read lightly, but there is no book on physiology which is so well worth reading.

To all but physiologists his fame will rest more on the Gifford Lectures, "Man on his Nature", written more than thirty years later, when he had retired from the chair at Oxford with every distinction which a scientist can gain. This book, with its general theme, gives more scope for his wide learning and tolerant humanity. It is a worthy memorial to his many-sided understanding of Nature.

His scientific work is, of course, his greatest achievement. He discovered the sensory apparatus of the muscles, he worked out the detail and the general plan of the hind limb reflexes, he showed that the inhibition of the muscles which oppose a movement is as important as the excitation of those that promote it, he analysed the features which distinguish conduction in the reflex arc from conduction in the nerve fibre, giving a picture of the spinal mechanism in terms of neurones and synapses which remains the basis of all current research. His work continued long after the publication of the "Integrative Action" and was constantly justifying the principles he had laid down. His laboratory at Oxford became the leading centre for research on the central nervous system: the list of his collaborators includes the most distinguished names in neurological research, and there was never a time when it could be said that new techniques and new ideas had left him behind.

In fact, Sherrington's understanding of Nature was based on first-hand inquiry, on fifty years of hard work in the laboratory, on acute observation and astonishing technical skill. But although he had to contend with the distractions of administration and high scientific office he never lost sight of the wood for the trees. Even in his most technical discussion he would startle us by a vivid pictorial analogy with a hint of wider horizons.

Without his poetry and philosophy Sherrington's scientific work would have lost much that made it so illuminating, and without his experience of scientific discovery his insight into the patterns of medieval thought could never have gone so deep. He could not have realized so clearly the problems which faced Fernel in the sixteenth century if he had not himself faced the problems of Nature and found a twentieth-century solution. But whatever he had written or discovered, he would have charmed his contemporaries and his juniors by his courtesy and genuine modesty and friendliness, as well as by the range of his ideas and his great stores of personal reminiscence.

His shorter poems reveal the qualities which made him so well loved. They will no doubt become the material for future dissertations in the literary schools, for they contain real treasures in a little room, furnished in a style no longer in fashion but made acceptable by the care which has gone to the furnishing. The same qualities of sympathetic understanding and the same powers of lively description stand out in his writings of people and events, his obituary notice of Ramón y Cajal or the letter published in *Nature* of February 21, 1948, p. 266, about his journey to Lewes in 1894 to give the newly discovered antitoxin to a small boy desperately ill with diphtheria. Here he is writing less formally, and one has a vivid picture of Sherrington as he used to talk, to a charmed group of listeners in the Combination Room or later in the bedroom at Eastbourne, where so many came to draw encouragement from his wisdom and charity.

In his long life he had enlarged the bounds of natural knowledge and he had shown how our ideas of the natural world have come to their present shape. He was too honest and too humble to produce any solution of ultimate problems; but he had set us all an example of how to accept our life, and we have lost one who was admired for himself as well as for his science.

E. D. Adrian

Trinity College,
Cambridge.

In speaking of his early days at Caius College, Sherrington once told me that Hering's idea of two fundamental opposite processes, anabolism and catabolism, held a strong position among his contemporaries. He gave the impression that this notion also had influenced his own thinking and experimentation, apart from stimulating a permanent interest in the physiology of vision. Not until very recently has it become fully appreciated how well Sherrington's own concepts of two truly antagonistic processes of central excitation and central inhibition have stood the test of time and become classical by the only applicable criterion, that of being alive, because they were founded on experimentation matured into far-reaching insight. To Sherrington, central excitation and inhibition were two active processes, both of which displayed similar properties with regard to spatial summation and facilitation, adding up algebraically on the motoneurone as if of opposite sign. Elaboration of these and a number of other sound and fundamental concepts in a very difficult field ranks as high among his many achievements as his three greatest experimental contributions, all of which were concerned with posture and locomotion: reciprocal innervation, the studies on muscle sense organs including their reflex effects, and decerebrate rigidity. His gift for discovery was never more beautifully displayed than when he proved the muscle spindle to be a sensory end-organ, discovered the complex reflexes from the muscle which govern locomotion and posture, and, finally, integrated all this new information into a structure of knowledge in which these reflexes, reciprocal innervation, decerebrate rigidity and several other facts of reflexology fell into their right places as pieces of one puzzle.

Sherrington was a great teacher, not *ex cathedra* because his mind was too intricate and held too many reservations to be at its best in pronouncement and simplification. His mind was always searching and wondering, approaching its subject from new angles. His gift as a teacher was that of genius: inspiration, shared generously in intercourse with the young. When perceiving genuine appreciation and sympathy, Sherrington allowed his vivid imagination free play and supported it by a wealth of information from his boundless stock of knowledge of facts, people and incidents collected from a life that had—or so it seemed—experienced everything from the beginning of the modern scientific age. The remarkable visual detail in everything he told engraved it upon one's memory while one was waiting for the amused chuckle and quick upward jerk of the head

that preceded the climax and showed what in each instance had caught his fancy.

He loved the French civilization and for this reason, among others, I want to refer to some words by Paul Valéry on how the instinct that keeps driving a man to complete a piece of sustained strenuous mental work is doomed to be antagonized by everything that is not of the spirit. But this resistance, he goes on to say, may bring into life unexpected resources of light and strength. Valéry wrote this of Descartes.

Those privileged to have lived within the radiation of Sherrington's orbit will always remember him as a man in whom the spirit, intellectually as well as emotionally, had explored all its boundaries and returned with unexpected resources of light and strength. Nothing human was alien to him.

Ragnar Granit

Nobel Institute for Neurophysiology,
Stockholm.

The passing of Sir Charles Sherrington, so many years after the close of his professional labour, must bring to many men a deep sense of sadness.

I can write of it only in terms of our personal relationship. No future Christmas will bring the "remembrances" from him that my wife and I had come to count on. No trip to England can ever again include a pilgrimage to see Sir Charles. But we, who have lived so far from him in body, have never been far from him in mind and now we shall not be cut off from him in spirit.

It was not the example of Horsley or Cushing that led me into the surgery of the nervous system. It was the inspiration of Sherrington. He was, so it seemed to me from the first, a surgical physiologist, and I hoped then to become a physiological surgeon. As years passed his influence did not grow less but stronger. Indeed, it often happens now that, during a routine operation, when the human brain of a conscious patient lies exposed and happy chance makes possible some observation that should throw light on physiological mechanism, I often seem to feel him looking over my shoulder.

In undergraduate days at Oxford, I remember once that he came behind me as I was carrying out my first mammalian experiment. For a little time he watched and then I heard him draw in his breath quickly, in a way he had of doing before he spoke, "You probably know how to do that better than I," he said, "but I should have thought . . .". I flushed and turned to him, thinking, for a moment, that he intended ridicule by his reference to my non-existent knowledge. But I learned better, for he was, of all men I have known, at once the most modest and the most intellectually honest.

In later years it never seemed to occur to him, as it has to one of his defenders, that such conclusions as we could draw from man were at variance with his own thinking. Indeed, he was thrilled by new evidence, and on our visits to him at Eastbourne in his later years, he, who never lost his zest for life, would remark with sparkling eyes, "It must be great fun to have the 'physiological preparation' speak to you".

Following the period of hospital training, I returned to Sherrington for postgraduate study at a time that may well have been the happiest period of his life. It was following the First World War. His son, Carr, had returned safe from overseas and Lady Sherrington was at his side. There was time for work and relaxation, for hospitality and reflexion.

No laboratory walls could shut in his spirit. He was a poet at heart and a philosopher, as well as a physiologist. What Oxford meant to him in those days he expressed in verse:

"The night is fallen and still thou speakst to me,
What though with one voice sole, with accents many,
Tongued turret and tongued stream, tracked pasture, fenny
And cloister, spirit trod, and centuried tree".

Nature did speak to Sir Charles Sherrington in many tongues. Early in life he passed from laboratory observations to an understanding of the integrative action of the nervous system and, in the process, he founded a school of neurophysiology. In later years he continued to hear the voice and interpreted it, though she spoke to him in other accents.

Wilder Penfield

McGill University,
Montreal.

Mr. W. S. Millard

On March 24, W. S. Millard died at Tunbridge Wells in his eighty-fifth year. He was the seventh son of the Rev. J. H. Millard and was born at Huntingdon. In 1887 he went out to Bombay to join the firm of Phipson and Co., and eventually became a partner. The late Herbert Phipson was a remarkable man who, besides founding and carrying on a very successful wine business, was the mainstay of the Bombay Natural History Society, and for eighteen years was secretary and editor of the Society's *Journal*. In 1893 Millard became joint editor, and when Phipson left India he succeeded him as secretary and held both offices until he finally returned to Britain in 1921. During his period of office the membership of the Society was greatly increased and the *Journal* enlarged. It was always his aim to encourage naturalists in India to write popular articles to attract more members, which would enable the size of the *Journal* to be increased and give more room for important scientific papers; in this way he built it up to become the most important scientific periodical in the East.

Millard's name will always be connected with the Mammal Survey of India, Burma and Ceylon, of which he was not only the originator, but also upon him fell the burden of raising money to keep three to four collectors in the field. The Survey began early in 1912, and up to 1915 he had raised Rs. 85,000; when it came to an end in 1923 more than fifty thousand specimens had been collected. Several thousands of skins were presented to the British Museum (Natural History), which now has the finest series of specimens from India, Burma and Ceylon, and made available material for the volumes compiled by Sir John Ellerman and the late Mr. R. I. Pocock.

Millard was a very keen gardener, especially interested in flowering trees and shrubs, and, in conjunction with the late Father Blatter, published in 1927 "Some Beautiful Indian Trees". Through his efforts the gardens of Bombay have been enriched with many fine flowering trees—none more beautiful than *Cassia renigera*, which he introduced from Burma in 1902.

He married Sybil, daughter of the late James Mackinlay, of Edinburgh, and is survived by a son and daughter.

N. B. Kinnear

Dr. Konrad Dobriner

MANY engaged in the biochemistry of cancer and related fields will have received with deep regret news of the death in New York on March 10 of Dr. Konrad Dobriner, of the Sloan-Kettering Institute and Memorial Hospital Center. Born at Elberfeld on October 14, 1902, Dr. Dobriner graduated from the University of Freiburg in 1925, and emigrated in 1933 to the United States.

Dr. Dobriner's earlier interests lay in porphyrin excretion, and later topics included the metabolism of specific carcinogens such as 1 : 2 : 5 : 6-dibenzanthracene, β-naphthylamine and dimethylaminoazobenzene, and the carcinogenicity of benzidine. Of recent years he had contributed largely to the establishment of the patterns of urinary excretion of the steroid hormones in normal and pathological states, the application of infra-red spectroscopy to steroid structure and metabolism, and the study of the effects of cortisone and related steroids on the growth of experimental tumours. From these later researches he was gradually evolving a view and interpretation of the role of adrenal cortical dysfunction in the inception and development of malignant disease as a whole.

WE regret to announce the following deaths:

The Right Hon. Sir Stafford Cripps, C.H., F.R.S., who was elected in 1948 to the Royal Society under Statute 12, which provides for the election of not more than one person a year for services to science, on April 21, aged sixty-two.

Sir Charles Inglis, O.B.E., F.R.S., emeritus professor of mechanical sciences in the University of Cambridge, on April 19, aged seventy-six.

Prof. F. H. Newman, C.B.E., professor of physics in University College, Exeter, on April 15.

Prof. John J. Nolan, professor of experimental physics, University College, Dublin, since 1920, on April 18, aged sixty-three.

NEWS and VIEWS

Quick Professorship in Cambridge: Prof. V. B. Wigglesworth, F.R.S.

VINCENT BRIAN WIGGLESWORTH, reader in entomology and director of the Agricultural Research Council Unit of Insect Physiology at Cambridge, has been appointed Quick professor of biology in the University. Prof. Wigglesworth, who was born in 1899, took an honours degree in science at Cambridge, followed by a period of biochemical research under Hopkins; he also qualified in medicine (M.D. 1929). He was a member of the staff of the Department of Entomology in the London School of Hygiene and Tropical Medicine during 1926–44. This appointment, of a young, untried graduate, as Wigglesworth then was, is of particular interest, and indeed proved most fortunate. One may suppose that, had the vacancy occurred a year or two earlier or later, Wigglesworth would have entered a medical career, and developed in a completely different way. But, as it was, a decision had been taken to develop the study of insect physiology: the appointment was made with that in view, and the policy followed with remarkable success. Wigglesworth's personal investigations have been on almost every side of insect physiology; they have been characterized by very careful planning, and in execution he has frequently taken a standard technique and adapted it for use on a small animal. Many of his methods have been beautifully simple, and his results have been so clear-cut that they have seldom needed statistical interpretation. His success in developing insect physiology is shown by his election to the Royal Society in 1939 and his appointment as Croonian Lecturer in 1948. His well-known book "The Principles of Insect Physiology" first appeared in 1939.

Provostship of Trinity College, Dublin: Prof. A. J. McConnell

THE appointment of Prof. A. J. McConnell by the Irish Government to the provostship of Trinity College, Dublin, in succession to the late Dr. E. H. Alton has been widely welcomed. Previous to the Treaty of 1921, the provostship was a Crown appointment, and since then it has been made by the Irish Government in Dublin. During this period, four provosts have been created and on each occasion the general wishes of the College have been consulted. Prof. McConnell has attained this high honour at the comparatively early age of forty-eight; in fact, to obtain a parallel case it is necessary to revert to Provost Andrews, who, in 1758, was appointed at the age of about forty-one. In dealing with the many difficulties, financial and otherwise, which now confront the College, this fact will be considered to be advantageous by many people. The new provost is a distinguished mathematician, and a worthy successor to the well-known mathematical and scientific provosts of the nineteenth century—the two Lloyds, Jellett and Salmon. His publications include a book on the "Applications of the Absolute Differential Calculus", and papers on relativity theory and other subjects. It is also fitting that he was co-editor with the late Prof. A. W. Conway of Volume 2 of Hamilton's mathematical papers. He has held the chair of natural philosophy (applied mathematics) for more than twenty years, and for the past two years has been also registrar of the College, in which post he has displayed considerable administrative ability. Apart from his more serious pursuits, he possesses the traditional interest of mathematicians in good music.

Sir George Beilby Memorial Fund: Awards for 1951

THE administrators of the Sir George Beilby Memorial Fund, representing the Institute of Metals, the Royal Institute of Chemistry and the Society of Chemical Industry, have made two awards for 1951, each of one hundred guineas, as follows: Dr. K. H. Jack for his experimental contributions to the study of interstitial alloys, especially in the iron–nitrogen and iron–carbon–nitrogen systems; and Dr. W. A. Wood for his experimental contributions to knowledge of the mechanism of deformation of metals.

Dr. K. H. Jack

Dr. Jack graduated in 1939 from Armstrong (now King's) College, Newcastle upon Tyne, and later

returned there, first as a demonstrator and then as a lecturer in physical chemistry. In 1945 he joined the British Iron and Steel Research Association and, continuing to work at Newcastle, carried out chemical and structural investigations on the iron–nitrogen, iron–carbon–nitrogen, and iron–carbon systems. This research was extended during 1947–49 at the Crystallographic Laboratory, Cavendish Laboratory, Cambridge, and included work on nitrogen martensite and on the tempering of nitrogen and carbon martensites. He is at present a lecturer in the Inorganic Chemistry Laboratories of King's College, Newcastle, and is working on the cobalt–carbon–nitrogen system and the ageing of nitrogen ferrites.

Dr. W. A. Wood

Dr. Wood joined the National Physical Laboratory, Teddington, in 1928 after graduating in physics from the University of Manchester. His first work was on the application of X-ray diffraction to the study of industrial materials, and led to early publications on the structure of magnet steels, electro-deposits and cold-worked metals. After taking his D.Sc. for work on the structural changes produced by the fatigue stressing of metals, he developed apparatus for precision measurements of the atomic spacings of metals under stress and obtained the first stress-strain curves for the atomic lattice of a metal. In 1947 he was appointed senior research fellow, with the status of associate professor, in the then newly established Metallurgy Research Department of the University of Melbourne, where he has directed the work of research students in metal physics and with them has been responsible in particular for new observations on the mechanisms by which metals become deformed at elevated temperatures.

Hyman Goldsmith Memorial Award of the *Bulletin of Atomic Scientists*

The Hyman Goldsmith Memorial Award of the *Bulletin of Atomic Scientists* has been made to Dr. Walter Gellhorn, professor of law in Columbia University, for his book "Security, Loyalty, and Science" (Cornell University Press, 1950; see *Nature*, 168, 305; 1951). The Award is given annually in honour of one of the founders of the *Bulletin*, H. H. Goldsmith, who died in August 1949, and is for the article, book or pronouncement which, in the opinion of a special committee appointed by the *Bulletin*, is the best contribution to the clarification of the right relations between science and politics.

Productivity in Industry

In replying to a debate in the House of Commons on the production efficiency of industry, on the adjournment on April 10, the Parliamentary Secretary to the Board of Trade, Mr. Henry Strauss, agreed with Mr. H. A. Watkinson, who opened the debate, that the time for sending teams to the United States is coming to an end, and stated that very few are now being sent and none after June. The Anglo-American Council on Productivity will come to an end when the work it is doing in collecting and transmitting information on the latest American techniques tapers off. The Government, said Mr. Strauss, is watching with interest the conversations in progress between the constituent bodies of the Council to determine whether any purely British body should be set up to take its place, but he would not agree that the new body should necessarily have a Minister as chairman or include members of the House of Commons. The business of increasing production, he continued, is non-party and non-political and, though the Government and Parliament can encourage it, it is primarily a task for industry.

New Technical University at Veszprém, Hungary

The new Veszprém Technical University, which is the main centre in Hungary for training and research in the heavy chemical industry, has recently announced the completion of its third building. It is hoped that a five-story laboratory building will be completed in the autumn next, and the main university building, containing lecture rooms, a large congress hall and the university library, are scheduled to be ready next year. The University contains four faculties: industrial chemistry, mineral oil and coal, electro-chemistry and silicate industry; for instructional purposes the University contains a small coking-plant, a pitch-distilling plant and an oil refinery. There are 520 students at present in residence; they study for four years, two years being devoted to general chemistry, and specialization beginning in the third year. Also at Veszprém are two research institutes, for heavy chemical industry and for mineral oil and natural gas, respectively. The former is housed temporarily in a wing of the University, but it is expected that its new building will be ready by next autumn; the institute is engaged on research into coke processes, the extraction of phenol from gas water, and on the production of low-price artificial fertilizers. The research institute for mineral oil and natural gas, which is situated near the University, has various departments, one of which, the motor research station, tests motor-fuel and lubricants under various conditions, including low temperatures.

Dynamic Machine for Testing Roads

A mobile vibration machine for testing roads, invented at the Shell Laboratories in Amsterdam, was demonstrated to road engineers at the recent Ninth International Road Congress in Lisbon. The test is non-destructive in that samples are not taken from the road. Measurements are made of the velocity of propagation of vibrations produced in the road structure by the machine, and picked up by electromagnetic geophones placed at various distances from it. A frame carrying three shafts with eccentric masses generates a sinusoidal force giving an amplitude of loading of 300–2,000 kgm. at frequencies within the range 5–60 c./s. The geophones are coupled to a low-frequency oscilloscope and an electronic voltmeter, the latter giving the amplitude of the vibration. The phase displacement of the vibration in the road surface is determined at various distances from the vibrator, and at various test frequencies, and the wave-length thus determined is plotted against frequency, from which the velocity of propagation is deduced. Velocities of propagation in each layer of a multi-layer road structure can be determined by measurements on the surface, and their elastic constants deduced, together with the rigidity of the construction. From the knowledge thus gained, it is hoped to develop a technique to determine whether the road has sufficient strength to meet the requirements of the traffic expected. So far, only one machine has been completed, and was used in tests at the Amsterdam International Airport, Schipol (see Van der Poel, C., Proc. 2nd International Conf. on Soil Mechanics, Rotterdam, 1948, 4, 157; *J. App. Chem.*, 1, 281 (1951); and *Electronic Measuring* (published by

Philips, Ltd.), 3, No. 5, 2). A description of the machine and of the tests at the Schipol Airport was given to the Roads and Building Materials Group of the Society of Chemical Industry at a meeting held at the Road Research Laboratory, Harmondsworth, in May 1950.

French Cartographic Surveys

MOST of Vol. 2 of the "Memoires et Documents" issued by the Centre de Documentation Cartographique et Géographique of the Centre National de la Recherche Scientifique (Pp. 301. Paris: C.N.R.S.; London: H. K. Lewis and Co., Ltd., 1951. 2,500 francs; 55*s*.) is occupied by a survey by J. Tricart of fruit cultivation in the Paris region in which the climatic and soil requirements, as well as the technical aspects of cultivation, the historical development of the industry and its present organization, are reviewed. There is also a survey by R. Bidault, J. Bonnamour, D. Curran, S. Daveau, J. Duloy, M. Henriot and S. Rimbert of cartographical data available on the agrarian geography of the Paris basin. Both these surveys are well documented, and the remainder of the volume lists the maps and aerial photographs of Belgium and Holland available at the Centre, with a bibliography of books and recent articles on the geography of Belgium and Holland.

Chemical Society—Officers

AT the annual general meeting of the Chemical Society, held in Dublin on April 16, the following officers were elected: *President*, Prof. C. K. Ingold; *Vice-Presidents*, Prof. E. L. Hirst and Sir John Simonsen; *New Members of Council*, Dr. D. H. R. Barton (London), Dr. N. Campbell (Edinburgh), Dr. J. Chatt (Welwyn), Dr. S. J. Gregg (Exeter), Dr. F. B. Kipping (Cambridge), Dr. E. A. Moelwyn-Hughes (Cambridge), Prof. A. Robertson (Liverpool) and Dr. M. A. T. Rogers (Manchester). Sir Eric Rideal, who retires from the office of president, becomes a vice-president. The secretaries of the Society are Prof. H. Burton, Prof. E. D. Hughes and Dr. L. E. Sutton.

Industrial Physics Conference in Glasgow

THE fourth conference on industrial physics, arranged by the Institute of Physics, will take place in the Royal Technical College, Glasgow, during June 24–28, the subject being "Physics in the Transport, Shipbuilding and Engineering Industries". In connexion with the conference an exhibition of instruments, apparatus and books relevant to the subject will be held, and more than seventy industrial firms and government departments will be participating in this. The programme of the conference includes lectures and discussions on metal physics, meteorology, the education and training of industrial physicists in Scotland, sound reproduction, physics in naval architecture, physics in transport, automatic control of industrial processes, and noise and its suppression. The conference will be opened by Lord Bilsland, president of the Scottish Council, and the principal speakers include Sir Andrew McCance, chairman of the organizing committee of the conference, and Sir Robert Watson-Watt. The conference will be open to all without charge; but admission will be by ticket only, obtainable from the Secretary, Institute of Physics, 47 Belgrave Square, London, S.W.1, to whom all inquiries should be directed.

Quality of Cereals and their Industrial Uses: Conference in Edinburgh

A JOINT conference of the Food and Agriculture Groups of the Society of Chemical Industry, in association with the Scottish Sections of the Society, will be held in the Edinburgh Suite of the Assembly Rooms, George Street, Edinburgh 2, during May 8–10. The subject of the conference will be "The Quality of Cereals and their Industrial Uses", and a number of lectures will be given, and excursions made, in connexion with this theme. The conference is open to all, and the registration fee is £2 for non-members and 10*s*. for members of the Society. Application forms (to be returned by April 30) and further details can be obtained from the Assistant Secretary, Society of Chemical Industry, 56 Victoria Street, London, S.W.1.

Problems of Arid Zones: Conference in Ankara

A CONFERENCE sponsored by the United Nations Educational, Scientific and Cultural Organization and the Turkish Government is being held in Ankara during April 25–29 to discuss hydrology problems of arid zones with special reference to underground water. The subjects include: the physical and chemical properties, as well as the statics and dynamics of underground water; the hydrological balance and the influence of utilization of underground water upon it; prospecting for underground water and adaptation of drilling methods to local conditions; and the relationship between the hydrology of underground water and other sciences. The delegates number about thirty and are drawn from the following countries: Algeria, Australia, Egypt, France, India, Israel, Lebanon, Mexico, Morocco, Pakistan, South Africa, Syria, Turkey, the United Kingdom and the United States. Before the opening of the symposium, the Advisory Committee on Arid Zone Research, the body set up by Unesco two years ago to make recommendations for putting into effect the programme of research on arid zones, met for three days during April 21–24. The proceedings of the conference will be published by Unesco in English, French, Spanish and Arabic.

Universities and Industry

A CONFERENCE on "Universities and Industry" will be held by the Manchester Joint Research Council on April 29 at the Chamber of Commerce, Ship Canal House, King Street, Manchester 2. The conference will be mainly based on the report of the productivity team which visited the United States in 1951 to study the relationship between American universities and industry. In the morning there will be, among others, addresses by three members of the team: Dr. C. R. Morris, vice-chancellor of the University of Leeds; Dr. D. S. Anderson, director of the Royal Technical College, Glasgow; and Mr. N. G. McCulloch, deputy chairman of the Calico Printers' Association, Ltd. The afternoon will be devoted to general discussion. Further details can be obtained from the Council at the above address.

Library Association: Conference in Bournemouth

THE annual conference of the Library Association will be held in Bournemouth during April 29–May 2, under the presidency of Mr. L. R. McColvin, librarian of the City of Westminster Public Libraries. The headquarters of the conference will be at the Grand

Hotel (Firvale Road), the registration and inquiry office will be in the Town Hall lounge, and sessions will be held as follows: general sessions, Winter Gardens (Exeter Road); annual lecture, Pavilion (Westover Road); and section meetings, Alexandra Hall (St. Peter's Road) and St. Peter's Hall (Hinton Road). In connexion with the conference there will be an exhibition of books, bindings and library equipment, to be held in the Grand Hall and Lounge of the Town Hall. Further information can be obtained from the secretary of the Association, Chaucer House, Malet Place, London, W.C.2.

Commonwealth Fund Fellowships for Study in the United States

The Commonwealth Fund of New York has awarded fellowships, tenable in American universities for one year beginning next September, to the following British graduates, among others: I. E. Bush, Pembroke College, Cambridge (biochemistry); L. J. Cohen, St. Andrews (mathematical logic); D. F. Gibbs, Edinburgh (medicine); R. H. Glauert, Trinity College, Cambridge (organic chemistry); V. K. A. M. Gugenheim, Magdalen College, Oxford (mathematics); H. E. Huxley, Christ's College, Cambridge (biophysics); W. B. Mims, Wadham College, Oxford (nuclear physics); N. A. Mitchison, Magdalen College, Oxford (genetics); C. R. Reifenberg, Trinity College, Cambridge (mathematics); R. B. Thompson, King's College, Newcastle upon Tyne (medicine); A. J. Weir, Jesus College, Cambridge (mathematics). In addition a Dominion Civil Service Fellowship has been awarded, among others, to H. D. Waring, Australia (forestry).

The Night Sky in May

Full moon occurs on May 9d. 20h. 16m. U.T., and new moon on May 23d. 19h. 28m. The following conjunctions with the moon take place: May 7d. 02h., Saturn 7° N.; May 9d. 03h., Mars 6° N.; May 21d. 21h., Jupiter 6° S.; May 22d. 10h., Mercury 7° S. In addition to these conjunctions with the moon, Venus is in conjunction with Jupiter on May 5d. 14h., Venus 0·3° S., and Mercury is in conjunction with Jupiter on May 17d. 02h., Mercury 1·8° S. Mercury, a morning star, is too close to the sun for observation, and Venus also is too close to the sun to be observed. Mars, in opposition on May 1, is visible throughout the night and does not set until the early morning hours. Jupiter, a morning star, rises at 4h. 25m., 3h. 30m. and 2h. 40m. on May 1, 15 and 31, respectively, but is too close to the sun for favourable observation until late in the month. Saturn is visible throughout the night and sets at 3h. 55m., 3h. and 1h. 55m. at the beginning, middle and end of the month, respectively. About the middle of the month it can be seen very close to γ Virginis. No occultations of stars brighter than magnitude 6 occur in May.

Announcements

A plaque in memory of Marconi has been placed by the London County Council outside 71 Hereford Road, Paddington, London. The inscription reads: "London County Council Guglielmo Marconi 1874–1937 The Pioneer of wireless communication lived here in 1896–1897".

The following appointments in the University of London have been announced: Dr. F. Bergel, to the University chair of chemistry tenable at the Institute of Cancer Research; Mr. Henry Terrey, reader in chemistry at University College, to a University chair of chemistry tenable at that College.

A scholarship, to be known as the *Farm Mechanization* Scholarship, has been given by the publishers of *Farm Mechanization* to the Institution of British Agricultural Engineers and will be applied for the benefit of students who have financial difficulty in completing the final year of their study for the National Diploma in Agricultural Engineering. Forms of application (to be completed by May 15) and further details can be obtained from the secretary of the Institution, 24 Portland Place, London, W.1.

The Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland are offering, for the academic year beginning October 1 or earlier, a limited number of postgraduate scholarships in agricultural economics, husbandry, statistics, and agricultural and dairy engineering. Further particulars and application forms (to be completed by May 15) can be obtained from the Secretary, Ministry of Agriculture and Fisheries (Research Branch II), 1–4 Cambridge Terrace, Regent's Park, London, N.W.1, or the Secretary, Department of Agriculture for Scotland, St. Andrew's House, Edinburgh 1.

Under the will of the late Arthur William Baxter, the sum of £2,000 has been left to the Institution of Naval Architects, the income of which, about £60 a year, is to be used for an annual Samuel Baxter Prize, or Prizes, to be awarded for the contribution towards safety and/or efficiency in sea-going vessels which, in the Institution's opinion, is the best during the year. The award will be open to all: papers read at the Institution will be automatically eligible and also any other work which may be submitted to the Institution. Further details can be obtained from the Secretary of the Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1.

The Ninth International Congress of Agricultural Industries will be held in Rome during May 23–31. Details of the programme can be obtained from Dr. D. Dickinson, Research Department, Saml. Hanson and Son, Ltd., Toddington, Cheltenham, Glos, or from the headquarters of the Congress, Via XX Settembre 98G, Rome.

The Associazone Italiana di Tecnica Navale is organizing a joint meeting in Italy with the Institution of Naval Architects to be held as follows: Genoa, September 25–27; Rome, September 28–30; and Naples, October 1–2. Six papers will be read, and a number of visits to shipyards and excursions have been arranged. Further details and application forms (to be completed by May 5) can be obtained from the Secretary of the Institution at 10 Upper Belgrave Street, London, S.W.1.

The seventeenth Cold Spring Harbor Symposium on Quantitative Biology will be held during June 6–13, the subject being "The Neuron". The following aspects of the problem will be discussed: optical, ionic, and metabolic phenomena of active nerves; electrotonus and excitation; the peripheral origins of nervous activity; activity of the neuron soma; the properties of dendrites; transmission at the neuromuscular junction, and at synapses of the invertebrate nervous system; sympathetic ganglia; and the central nervous system of vertebrates. Further details can be obtained from the Biological Laboratory, Cold Spring Harbor, New York.

ACTION OF SNAKE VENOM ON ACETYLCHOLINE SYNTHESIS IN BRAIN

By Dr. B. M. BRAGANCA and Prof. J. H. QUASTEL, F.R.S.
Research Institute, Montreal General Hospital, Montreal

WHILE investigating the highly inhibitive effects of venoms on metabolic processes in isolated tissues[1], we have had occasion to examine their influence on the rate of acetylcholine synthesis in brain tissue. It is the purpose of the following statement to describe the effects that have been obtained and to offer a possible explanation for them. Venoms heated at 100° C. for fifteen minutes have been used in these investigations. Such venoms still show marked toxicity to animals, as was shown by Weir Mitchell[2]; but they have lost, owing to heat inactivation, almost all the enzymes that are normally present in venoms. In fact, the only enzyme still known to be present in such a heat-treated venom is lecithinase[1].

Technique. An aqueous solution of the venom (300 μgm./ml.) is heated in a boiling-water bath for fifteen minutes and the coagulum is removed by centrifuging. The clear supernatant is used for the investigations. Analysis shows that the protein content of the supernatant is approximately half that present in the original solution.

Experiments are carried out using the Warburg manometric apparatus, in the vessels of which are placed preparations of fresh brain mince, or brain homogenates, in the presence of appropriate media with or without the venom. The manometric vessels are shaken at 37° C. for one or two hours, air being present as the gaseous phase. The technique adopted for observing total and free acetylcholine synthesis is that of Mann, Tennenbaum and Quastel[3]. Brain homogenates are prepared by using the Potter–Elvehjem homogenizer, fresh rat brain being disintegrated in a neutral solution containing 0·9 per cent sodium chloride and 0·7 per cent cystein. The brain is sufficiently broken down to allow the use of a pipette with a relatively wide tip. The various media used in the incubation experiments have the following composition: Locke solution (potassium chloride, 0·004 *M*, and calcium chloride, 0·002 *M*); sodium chloride, 0·13 *M*; glucose and sodium pyruvate, 0·01 *M*; eserine, 0·033 per cent. The amount of brain tissue (as mince or homogenate) placed in each vessel is 280 mgm. wet weight in 1 ml.

Effect of heated cobra venom on acetylcholine formation in brain. Typical results showing the effects of the addition of heated cobra venom on acetylcholine formation in the presence of brain preparations are shown in Table 1. The following conclusions may be drawn. First, the synthesis of acetylcholine, under the given experimental conditions, proceeds at a faster rate in a brain mince than in a brain homogenate. The respiration of brain mince under the given experimental conditions also considerably exceeds that of the homogenate. The results are in accordance with the findings of Mann *et al.*[3], who pointed out that conditions that lower the respiration of isolated brain may also result in a diminished rate of synthesis of acetylcholine. The amount of synthesized bound acetylcholine found in a mince is, usually, at least one-third of the total. After incubating the brain preparations in the presence of the heated venom, almost all the acetylcholine synthesized is found in the free condition. This observation recalls the finding of Corteggiani[4] that lecithinases present in cobra venom may release acetylcholine from the bound form. When brain homogenates are employed, the presence of heated cobra venom usually produces about a 30 per cent increase in the rate of synthesis of the total acetylcholine, the increase being in the form of the free ester. This is a remarkable result when it is considered that the presence of the heated venom brings about a decrease in the rate of oxygen uptake of the preparation (Table 1, Experiment 1).

Table 1. Effect of Heated Cobra Venom (300 μgm./ml.) on Aerobic Acetylcholine Synthesis by Rat-Brain Tissue

Expt.	Constituents present	Acetylcholine* μgm./gm. in 2 hr. at 37°			
		Free	Bound	Total	Oxygen uptake (μl./2 hr.)
1 (*a*)	Brain homogenate + glucose + phosphate + Locke medium + choline + eserine	10·0	5·0	15·0	245
(*b*)	As in Expt. 1 (*a*) + heated cobra venom	20·0	2·0	22·0	165
2 (*a*)	Brain mince + glucose + phosphate + Locke medium + choline + eserine	13·3	15·5	28·8	355
(*b*)	As in Expt. 2 (*a*) + heated cobra venom	25·6	0·0	25·6	242
3 (*a*)	Brain homogenate + glucose + phosphate + Locke medium + choline + eserine + 0·027 *M* potassium chloride	20·4	5·2	25·6	
(*b*)	As in Expt. 3 (*a*) + heated cobra venom	52·8	4·8	57·2	
4 (*a*)	Brain homogenate + sodium pyruvate + phosphate + Locke medium + choline + eserine + 0·027 *M* potassium chloride	20·6	6·1	26·7	
(*b*)	As in Expt. 4 (*a*) + heated cobra venom	40·0	8·1	48·1	

* Preformed acetylcholine = 5·0 μgm./gm.

There is no increase in the total acetylcholine in presence of the heated venom when a brain mince is used. It seems probable that the lesser effect of the venom on the mince than on the homogenate is due to a poorer access of the venom to the responsible tissue elements.

The second conclusion to be drawn is that in the presence of excess potassium ions (0·027 *M*) heated cobra venom exercises a large accelerating effect on the rate of acetylcholine synthesis by a brain homogenate, whether glucose or sodium pyruvate is the substrate (see Experiments 3 and 4, Table 1). The rate of synthesis may be increased, by the venom, by more than a hundred per cent. The increase of acetylcholine synthesis seems to be entirely in the form of free acetylcholine.

This phenomenon is perhaps understandable on the hypothesis made by Mann *et al.*[3] that the process whereby bound acetylcholine is converted into free acetylcholine is a rate-limiting step in the aerobic syn-

thesis of total acetylcholine in the brain. If the rate of this conversion is accelerated by the presence of heated venom (as experiments show to be the case), the rate of aerobic synthesis of total acetylcholine will also be increased, so long as the rate of respiration is sufficiently high to prevent the yield of adenosinetriphosphate becoming the limiting factor. On this hypothesis, heated cobra venom exercises its activating effect on acetylcholine synthesis because of the presence of a lecithinase, or a phospholipase, that is capable of breaking down bound into free acetylcholine. The bound acetylcholine may be a phospholipoid complex or a lipoprotein complex[5], or it may simply be free acetylcholine held within the mitochondria the structure of which is capable of being broken down by venom lecithinase[1]. The greater effect of the heated venom on acetylcholine synthesis in the presence of potassium ions may be due primarily to the activating action of these ions on the acetylcholine synthesizing system.

Another point of view, however, is that the venom effects a change of permeability of the mitochondria whereby adenosinetriphosphate becomes more accessible to the choline acetylase system outside these structures.

Effect of heated venom on acetylcholine synthesis in a brain extract. It is now well known that acetylcholine synthesis can take place in an extract of acetone-dried brain in the presence of adenosinetriphosphate. The enzyme system involved has been termed choline acetylase. It is clear that a variety of components is involved in this synthetic system, and the term choline acetylase is therefore now reserved specifically for that enzymic component concerned in the transfer of an acetyl group from coenzyme A to choline[6].

The results of addition of heated venom to a choline acetylase system indicate a complete lack of activity of the venom. No inhibition of acetylcholine synthesis takes place. A typical result is shown in Table 2. The inference would be that the heated venom is incapable of attacking the phosphorylation or other mechanisms involved in the synthesis of acetylcholine in the presence of adenosinetriphosphate.

Table 2. Action of Heated Cobra Venom on Anaerobic Synthesis of Acetylcholine by Extract of Acetone Powder of Beef Brain* (2 hr. at 37° C. in 93 per cent nitrogen and 7 per cent carbon dioxide)

Expt.	Constituents of system	Acetylcholine (μgm./ml.) synthesized in 120 min.
A	Brain extract + NaCl (0·078 *M*) + KCl (0·027 *M*) + $MgSO_4$ (0·004 *M*) + cystein (0·017 *M*) + choline chloride (0·0008 *M*) + NaF (0·05 *M*) + sodium citrate (0·0083 *M*) + eserine sulphate (0·033 per cent) + ATP (0·003 *M*) + $NaHCO_3$ (0·047 *M*)	140
B	As in Expt. *A* + heated cobra venom (300 μgm./ml.)	140

* Prepared according to the directions of Harpur and Quastel[7].

This conclusion gives support to the hypothesis, already stated, that the activating effect of the heated venom on aerobic synthesis of acetylcholine in brain is due to its breakdown of bound acetylcholine. The bound ester is apparently only produced under conditions where there is an active respiration.

Heated venom and acetylation of sulphanilamide. Experiments which will be reported in detail elsewhere[1] have also shown that the acetylation of sulphanilamide in an extract of acetone-dried pigeon liver is unaffected by heated cobra venom in the presence of added adenosinetriphosphate. If, however, the energy for the acetylation process is obtained through the metabolism of pyruvate, the acetylation of sulphanilamide may be greatly inhibited, the inhibition depending on whether the pyruvate is metabolized by a process which is itself inhibited by the heated venom.

Thus, when the synthesis of acetylsulphanilamide by an extract of acetone-dried pigeon liver is allowed to proceed in the presence of a brain homogenate accomplishing the oxidation of pyruvate (a process which is inhibited by heated venom), the heated cobra venom inhibits the synthesis of acetyl sulphanilamide by 50 per cent. When the energy is derived, however, from the anaerobic dismutation of pyruvate in the presence of an extract of acetone-dried pigeon liver powder (a system not inactivated by heated venom), the synthesis of acetyl sulphanilamide is unaffected by the presence of heated cobra venom.

These results on biological acetylations demonstrate that heated venom has no direct inhibitory action on the acetylation process, and illustrate the manner in which the inhibitory effect of heated venom on respiratory processes may influence acetylations.

Effect of the presence of calcium ions on acetylcholine synthesis in the presence of heated venom. It is well known that calcium ions activate lecithinase[8]. It seemed desirable, therefore, to examine the effects of these ions on acetylcholine synthesis in the presence of heated venoms. Although, under the given experimental conditions, excess calcium ions (0·02 *M*) do not depress acetylcholine synthesis by a brain homogenate in the presence of 0·027 *M* potassium chloride, they exert a considerable depressing effect on the stimulating action of heated cobra venom on acetylcholine formation. Typical results are shown in Table 3. Almost the whole of the accelerating effect of the venom may be abolished by the presence of the calcium ions. This phenomenon occurs whether the synthesis by the brain homogenate takes place in a phosphate or in a bicarbonate

Table 3. Effect of Calcium Ions on the Inhibition of Metabolism in Rat-Brain Homogenates by Heated Cobra Venom (300 μgm./ml.)

Expt.	Constituents present	Total acetylcholine formed (μgm./gm.)	Oxygen uptake (μl./hr.) 2 hr.	Percentage inhibition of oxygen uptake by heated venom
1 (*a*)	Brain homogenate + glucose + phosphate Locke medium + 0·027 *M* potassium chloride	20·0	604	
(*b*)	As in Expt. 1 (*a*) + heated venom	47·2	442	27·0
(*c*)	As in Expt. 1 (*a*) + 0·020 *M* calcium chloride	20·8	375	
(*d*)	As in Expt. 1 (*a*) + 0·020 *M* calcium chloride + heated venom	28·4	103	72·5
2 (*a*)	Brain homogenate + glucose + bicarbonate + Locke medium + 0·027 *M* potassium chloride	21·2		
(*b*)	As in Expt. 2 (*a*) + heated venom	38·4		
(*c*)	As in Expt. 2 (*a*) + 0·020 *M* calcium chloride	32·0		
(*d*)	As in Expt. 2 (*a*) + 0·020 *M* calcium chloride + heated venom	32·0		

TABLE 4. COMPARISON OF THE EFFECTS OF HEATED RUSSELL'S VIPER VENOM AND COBRA VENOM ON ACETYLCHOLINE SYNTHESIS BY A RAT-BRAIN HOMOGENATE

Expt.	Constituents present	Acetylcholine formed (μgm./gm.)			Lecithinase activity of venom (arbitrary units)*
		Free	Bound	Total	
1	Brain homogenate + glucose + phosphate + Locke medium + 0·027 *M* potassium chloride	10·7	11·7	22·4	
2	As in Expt. 1 + heated Russell's viper venom (300 μgm./ml.)	16·0	12·8	28·8	31
3	As in Expt. 1 + heated cobra venom (300 μgm./ml.)	52·8	3·8	57·6	105

* Lecithinase activities were estimated by a manometric technique[1].

medium. It is important to note, however, that the presence of the excess calcium ions concurrently brings about a very large increase in the inhibition of oxygen uptake produced by the heated venom (Experiment 1, Table 3). This fact suggests the likelihood that in the presence of venom the supply of energy (in the form of adenosinetriphosphate) has become the limiting factor in the synthesis of acetylcholine by the brain homogenate and that the depressing effect of calcium is due to a lowered rate of oxygen uptake and hence a diminished rate of adenosinetriphosphate formation.

Thus it would appear that an initial increase in the rate of acetylcholine synthesis in a brain homogenate, by the addition of heated venom, may be followed by a decreased rate of synthesis as the venom lecithinase gradually diminishes respiratory activity and hence the formation of adenosinetriphosphate.

Comparison of effects of heated Russell's viper venom and cobra venom on acetylcholine synthesis by rat-brain homogenate. It was of interest to compare the action of cobra venom on acetylcholine synthesis with that of Russell's viper venom, with special reference to their relative lecithinase activities. In this connexion it may be noted that Corteggiani[9] has claimed that the crude venom of *Vipera aspis* fails to liberate free acetylcholine from the complex in brain minces, under conditions in which cobra venom produces complete degradation of the combined form. The action of Russell's viper venom on acetylcholine synthesis is also of interest in view of the fact that this is a non-neurotoxic venom, its toxic symptoms being associated with effects on the blood system. Typical results of the action of Russell's viper venom as compared with that of cobra venom are given in Table 4. It is noteworthy that heated Russell's viper venom produces only a much smaller increase in the total synthesis of acetylcholine, by a brain homogenate, than that produced by heated cobra venom under similar experimental conditions. Moreover, Russell's viper venom has relatively little lecithinase activity compared with that of cobra venom. These findings are in accordance with the view that lecithinase action is involved in the accelerative action of heated cobra venom on acetylcholine synthesis in a brain homogenate.

Summary. Cobra venom, heated to inactivate all enzymes present except lecithinase but which still retains toxicity to the animal, has a two-fold effect on acetylcholine metabolism in the brain. The heated venom brings about a rapid breakdown of bound acetylcholine into the free ester. It also produces a pronounced increase in the rate of synthesis of acetylcholine by a brain homogenate, the increase being stimulated by the presence of excess potassium ions. The heated venom, however, has no inhibitory effect on the acetylation of choline or of sulphanilamide in tissue extracts in the presence of adenosinetriphosphate. It is concluded that a lecithinase present in heated venom initially affects acetylcholine synthesis in respiring brain homogenates, either by accelerating the rate-limiting step involved in the formation of free from bound acetylcholine, or by changing the permeability of mitochondria for adenosinetriphosphate. A decrease, however, in acetylcholine synthesis occurs when, ultimately, the lecithinase brings about a marked diminution in respiratory activity and hence in the rate of formation of adenosinetriphosphate.

Grateful acknowledgment is made to the National Cancer Institute of Canada for a grant-in-aid to this Institute, to the Banting Research Foundation for a grant to one of us (B. M. B.), and to Mr. Peter Faulkner for his assistance.

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NATURAL CONSERVATION OF INSULAR PLANKTON

By BRIAN P. BODEN

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MOST benthic animals are planktonic in their larval stages. By this means, continental benthic forms are able to take advantage of diffusion processes and currents to maintain or extend their population boundaries. The benthos of an oceanic island, however, is faced with the problem of conserving rather than dispersing its pelagic stages, and diffusion and large-scale current systems are inimical to this. In addition, most islands have permanent neritic plankton communities which must also overcome these adverse processes.

The probable method by which this is accomplished in the summer in Bermuda waters is demonstrated here by standard physical oceanographic analysis.

Bermuda is the partially submerged peak of an extinct volcano. The partial submergence and subsequent coral growth has given it a superficial resemblance to an atoll (Fig. 1). The sub-aerial part of the peak is confined almost entirely to the string of islands in the south-east. The remainder consists of a platform with marginal reefs. The platform has an average depth of about 15 metres, and the reefs vary from a couple of feet above to several feet below low-tide level. Scattered about the platform are many coral-heads and reefs as shoal as the marginal reefs, and there are many holes with depths greater than mean floor depth. The outer reefs are

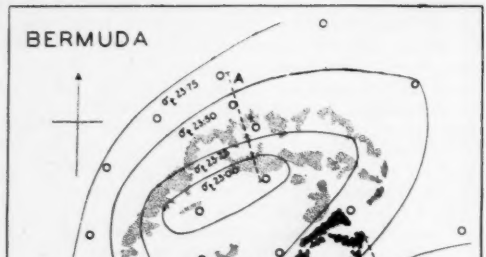


Fig. 1. Map of Bermuda and plan of stations. The islands are shown solid black, reefs are dotted and stations represented by small circles. Intersections of σ_t surfaces with surface of the sea are also shown. Dotted lines *A* and *B* are temperature transects shown in Fig. 2

not continuous, and free exchange is possible between the lagoon water and the surrounding ocean water.

During the summer months there are no prevailing winds of great magnitude or duration. For long periods the air above the islands is hot, still and humid. Local wind-driven circulation is thus reduced to a minimum.

The results discussed here were obtained in the course of a short hydrographic cruise during which twenty-eight stations were occupied around the island and in the lagoon (Fig. 1). Throughout the cruise, and for some time prior to it, typical summer conditions prevailed. Temperatures and water-samples were taken at standard depths from the surface to 100 m. or the bottom, by means of a Pettersson–Nansen insulating bottle. Vertical plankton hauls were made from 50 m. or the bottom with a 70-cm. open Nansen net of 2XX mesh bolting-silk. Bathythermograph records were made with a sensitive, shallow (60-ft.) bathythermograph. At the outside stations a deep bathythermograph was also used to 100 m.

Salinities and temperatures in the lagoon were consistently higher than in the outside waters. In the lagoon, surface salinities ranged up to 36·56 ‰, and surface temperatures ranged up to 30·15° C., while the air temperature 10 ft. above sea surface was around 28·0° C. Outside the lagoon surface salinities were about 36·31 ‰, surface temperatures about 27·61° C., and air temperature was around 28·0° C.

In Fig. 1 are shown the intersections of σ_t surfaces (equal density at zero pressure) with the surface of the sea. Such a distribution of density is necessarily associated with an anticyclonic water movement, and the circulation is therefore thermal, opposing a haline circulation. This general anti-cyclonic drift has been indicated in previous years by drift-bottle surveys.

Fig. 2 shows the vertical thermal structure in the two sections marked *A* and *B* in Fig. 1. Similar sections all around the island reveal essentially the same temperature pattern, the isotherms sloping downward and inward from a surface convergence toward the reef. σ_t curves of values found in the convergence (23·40–23·50) slope in the same direction (superimposed on isotherms in Fig. 2). Surface water probably sinks along these σ_t surfaces and is thereby returned to the lagoon. Thus a convection current system exists whereby the anti-cyclonically revolving lens of warm, highly saline water above and surrounding the Bermuda platform tends to spread out over the surface of the adjacent water until it reaches a convergence in the neighbourhood of the σ_t 23·50 curve shown in Fig. 1. By now it is sufficiently cooled to sink along these higher σ_t surfaces, and most of it is thus returned to the lagoon, partially reinforced by oceanic water, due to vertical mixing across the σ_t surfaces in the convergence.

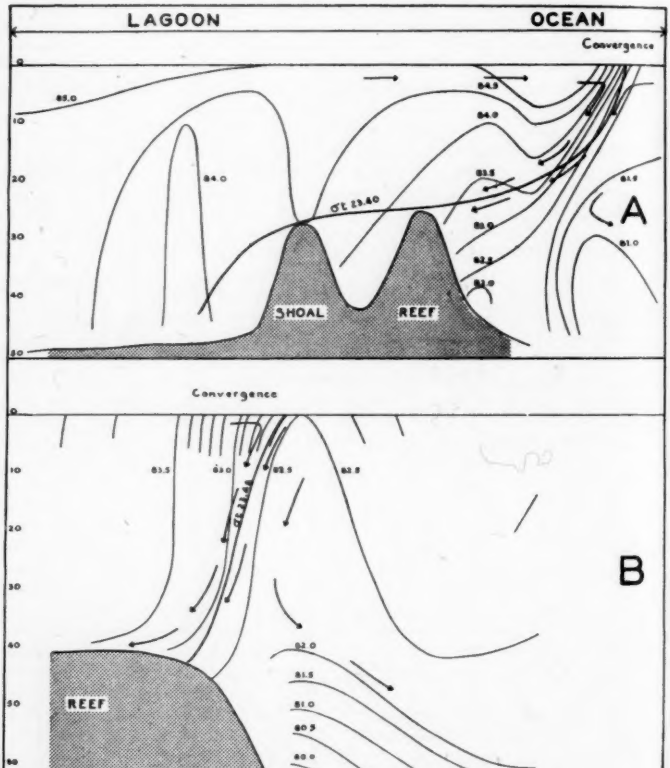


Fig. 2. Vertical thermal structure in sections marked *A* and *B* in Fig. 1. Depth is in feet, temperature in degrees Fahrenheit. A σ_t surface has been superimposed on the isotherms in each case

Plankton volumes were found to be consistently higher at all the lagoon stations than at the outer stations. To test the hypothesis that this convergence is the means whereby the lagoon plankton is conserved, oblique tows from 15 m. with a one-foot open plankton net (2XX mesh) were made at short intervals along section *B* (Fig. 1). On the island side of the convergence, plankton volume (measured by displacement) was 1·0 ml./30 min. haul. In the convergence this rose to 1·5 ml./30 min. haul, whereas in the outer waters it dropped to 0·1 ml./30 min. haul. There is therefore a concentration of plankton in the convergence.

Fathograms made in the neighbourhood of the convergence reveal the presence during day-time of shallow, sonic-scattering layers most probably indicating high plankton concentrations and associated nektic forms.

It is of interest that these processes occur during the summer months, when the reproductive activities of most benthic creatures, for example, the Bermuda lobster, are most intensive.

SYNTHESIS OF 'BLOCK' COPOLYMERS

By A. S. DUNN and Prof. H. W. MELVILLE, F.R.S.

Chemistry Department, University of Birmingham

LINEAR macromolecules containing two monomeric residues may be synthesized simply by making a homogeneous mixture of the two monomers and initiating polymerization in the usual way. The overall composition of the copolymer can be determined by a variety of methods, and it is further believed that the two units occur in a perfectly definite sequence dependent only on the composition of the copolymer. The properties of such copolymers differ markedly from mechanical mixtures of the pure polymers. This is the reason for the present extensive work on copolymers. There is, however, a third conceivable type of system in which blocks of one type of residue recur regularly, to be succeeded by blocks of the second residue. Such a block type of copolymer might be expected to have properties differing markedly from the copolymer and the mixture of pure polymers. The present communication describes some efforts that have been made to synthesize macromolecules of this kind of structure.

The basis of the first method consists in suspending a water-insoluble monomer in an aqueous solution of a water-soluble monomer; polymer radicals generated in one phase then diffuse across the phase boundary and add monomer in the other phase, producing a block polymer. Suitable monomers are acrylic and methacrylic acids[1], which give water-soluble polymers, and styrene; unfortunately, the solubility of the monomeric acids in styrene is considerable, so that a pure styrene block cannot be obtained but only a styrene – acid copolymer block.

If the distribution coefficients of acrylic and methacrylic acids between water and styrene and therefore the concentration of the acid in the styrene phase is known, the composition of the oil-phase copolymer may be calculated from the copolymer composition equation[2], using the known monomer reactivity ratios[3].

Polymerization was initiated in the aqueous phase using uranyl nitrate as photosensitizer; the polymer was precipitated with methanol, which dissolved the monomers and the emulsifying agent—sodium dodecyl sulphate. The product was not completely soluble in any substance except pyridine, though some material could be extracted with chloroform. By contrast, polymers of methacrylic acid and styrene and their copolymers are soluble either in alcohol or chloroform. Acid hydrolysis[4] of a methyl acrylate – styrene block polymer prepared by the second method gives a similar material soluble only in pyridine.

Elementary analysis of the chloroform-soluble material showed it to contain significantly more acid than would be required by the oil-phase copolymer formed under the conditions employed. Conversions were low (less than 10 per cent); the discrepancy could not be explained by the variation of copolymer composition with conversion[5].

Table 1

	Analysis		Mole fraction acid
	C	H	
Methacrylic acid – styrene chloroform soluble block polymer	86·66	7·63	0·185
Oil-phase copolymer	(88·8)*	(7·63)*	0·111
Acrylic acid – styrene chloroform soluble block polymer	75·26	7·10	0·495
Oil-phase copolymer	(91·0)*	(7·5)*	0·050

* Analyses calculated

Material which had not been reprecipitated from chloroform gave an analysis with a high ash content, but the infra-red spectrum of the powder showed only bands attributable to styrene or methacrylic acid.

The second method consists in synthesizing a polymer with end-groups that can be induced photochemically to form polymer radicals, which then initiate polymerization of a second monomer in which the polymer is dissolved. For this purpose polystyrene containing bromo- and tribromomethyl end-groups was prepared by polymerization of styrene in the presence of carbon tetrabromide, which is a very efficient transfer agent[6]. Carbon tetrabromide absorbs light of wave-lengths[7] less than 400 mμ and will photosensitize the polymerization of styrene. Thus carbon tetrabromide will act both as initiator and transfer agent, so that the introduction of initiator fragments which would form inactive end-groups can be avoided. Though each polymer molecule may not contain four bromine atoms, this material may be designated as 'polystyrene tetrabromide' for convenience. Bromotrichloromethane may advantageously be substituted for carbon tetrabromide.

Table 2

Monomer	Initial rate of polymerization (per cent/min.)
Methyl methacrylate containing 9·1 per cent v/v polystyrene tetrabromide $\bar{M}_n$ = 6,000	0·070
Methyl methacrylate with 9·1 per cent inactive polystyrene	0·016
Methyl acrylate with 12 per cent v/v polystyrene tetrabromide $\bar{M}_n$ = 6,000	0·145
Methyl acrylate with 5·9 per cent polystyrene tetrabromide $\bar{M}_n$ = 114,000	0·054
Methyl acrylate with 5·9 per cent inactive polystyrene	0·030
Methyl acrylate	0·028

Table 2 shows that polystyrene tetrabromide photosensitizes the polymerization of another monomer such as methyl methacrylate or methyl acrylate.

Neglecting possible effects of transfer to the polystyrene tetrabromide, the molecular weight of the polymethyl methacrylate portion of the molecule may be calculated. The rate of initiation I is calculated from the measured rate of polymerization R:

$$I^{1/2} = \frac{k_t^{1/2}}{k_p} \cdot \frac{R}{(A)},$$

where k_p and k_t are growth and termination velocity coefficients for the polymer radical, and the molecular weight of the polymethyl methacrylate

$$\overline{M}_n = M_0 \frac{k_p}{k_t^{1/2}} \cdot \frac{(A)}{I^{1/2}},$$

where (A) is the concentration of the monomer and M_0 is its molecular weight.

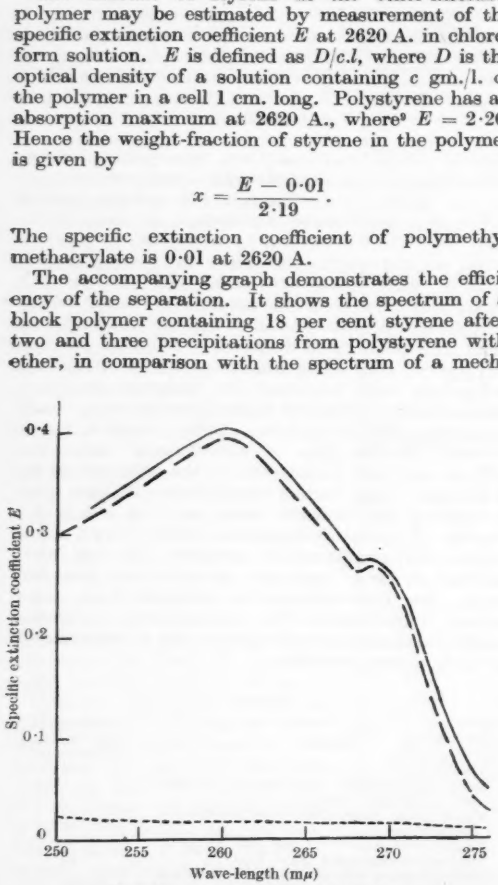
Precipitation of the product from benzene or chloroform solution with ether allows the residual polystyrene to be removed cleanly; polystyrenes of molecular weight less than 25,000 are completely soluble in ether[8].

The amount of styrene in the ether-insoluble polymer may be estimated by measurement of the specific extinction coefficient E at 2620 A. in chloroform solution. E is defined as $D/c.l$, where D is the optical density of a solution containing c gm./l. of the polymer in a cell 1 cm. long. Polystyrene has an absorption maximum at 2620 A., where[9] $E = 2{\cdot}20$. Hence the weight-fraction of styrene in the polymer is given by

$$x = \frac{E - 0{\cdot}01}{2{\cdot}19}.$$

The specific extinction coefficient of polymethyl methacrylate is 0·01 at 2620 A.

The accompanying graph demonstrates the efficiency of the separation. It shows the spectrum of a block polymer containing 18 per cent styrene after two and three precipitations from polystyrene with ether, in comparison with the spectrum of a mechanical mixture of the same polystyrene as was used in the synthesis of the block polymer after one precipitation. The latter is identical with the spectrum of pure polymethyl methacrylate, while the former agrees within the experimental error.



Absorption spectra in chloroform solution
———, Block polymer precipitated twice from chloroform with ether; — — —, Block polymer precipitated three times from chloroform with ether; - - - - -, mixture of polystyrene and polymethyl methacrylate after precipitation from chloroform with ether

Table 3

Calculated		Found
in block polymer	in mixture	
4·2	1·75	2·0
4·67	2·39	2·37
34·0	20·2	15·0

The composition of the block polymer may be calculated from the molecular weights of the polystyrene tetrabromide $\overline{M}_A$ and of the polymethyl methacrylate formed $\overline{M}_B$:

$$\text{Mole fraction of styrene} = \frac{\overline{M}_A}{\overline{M}_A + \overline{M}_B}.$$

Table 3 shows that the styrene contents calculated and found (columns 1 and 3) are not in agreement. However, allowance has been made for the bromine atom which is photolysed off the polystyrene tetrabromide and which also initiates polymerization of the methyl methacrylate, when it will give rise to a polymer identical in molecular weight with the methacrylate block. When the ether-insoluble polymer is regarded as a mixture of this polymethyl methacrylate with the block polymer, agreement between the compositions is satisfactory. [Jan. 28.

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FEDERAL FORESTRY ADMINISTRATION IN MALAYA

ANNUAL REPORT FOR 1950

WHEN the troublous times in Malaya are remembered, the report on Federal Forest Administration in the Federation of Malaya for the Year 1950, by J. P. Edwards, director of forestry*, furnishes proof that part of the Civil administration is carrying on in the full interests of the country as a whole, in spite of almost insuperable difficulties. The report is divided into two main parts, the first covering Federated activities centred around forestry and forest products, research, education, engineering, local timber supplies and the timber export trade; the second gives a combined general review covering forest reservation, management, production and finance, together with a précis of the individual annual forest reports for each of the States and Settlements of the Federation, including a report for Singapore.

*Report on Federal Forest Administration in the Federation of Malaya for the Year 1950. By J. P. Edwards. Pp. 66. (Kuala Lumpur: Government Printer, 1951.) 2 Malayan dollars, 4s. 8d.

It could not be expected that forestry work out in the jungles could be carried on without danger. Four forest rangers and guards and a number of Chinese employed in forest work were killed during the year, and saw-mills and departmental buildings and several hundred tons of sawn timber were burnt. A number of forest officers were taken from their normal duty, so that their knowledge of the jungles could be used in the present military operations; this has come hard on the department, and necessitated the curtailing of important work. In connexion with the maintenance of the export timber trade, the report says: "The value of timber exported to the United Kingdom again showed a spectacular increase. Much of this timber was in the form of mixed light hardwoods which are largely used in the United Kingdom as a substitute for soft woods normally obtained from hard currency areas". Malaya came fifth in this type of export to the United Kingdom. It appears that the state of the country and the difficulty of protecting the men employed in the old methods of hand-logging so prevalent in the forests of the East and Far East are bringing about logging by tractor; it is said that a demonstration in Selangor proved conclusively that extraction costs could be greatly reduced and did much to dispel fears that tractors might not be able to handle timber.

It is impossible to review the report in all its details of the work done, including the carrying on of research work of considerable importance; but the Bangkok Conference is worthy of mention. The inaugural session of the Forestry and Forest Products Commission for Asia and the Pacific was held at Bangkok during October 9–18, with Mr. Edwards leading the British delegation. As he says, "the existence of a Commission for this part of the world fulfils a definite want and will provide a convenient medium for the discussion of common problems". A great deal of useful work was got through at the Conference; but the warning note was struck that "the success of the Commission will very largely depend on how far Member Governments find themselves able to implement the recommendations made at Mysore and Bangkok". Past experience of similar such commissions teaches that this one will mainly stand or fall on the extent to which government administrations realize how their property can benefit economically as a result of the work accomplished.

BODY TEMPERATURES IN NESTLING WESTERN GULLS

ALTHOUGH it has been known for more than half a century that some kinds of young birds have only limited capacity to control body temperature, data on the ontogenetic development of temperature regulation are available for few species of wild birds, either altricial or precocial.

In June 1950 advantage was taken of the opportunity afforded by a large breeding colony of western gulls (*Larus occidentalis wymani*) at Santa Barbara Island, and the body temperatures of more than sixty nestlings were taken by G. A. Bartholomew, jun., Wm. R. Dawson and R. D. Collyer (*Condor*, 54, No. 1; January–February 1952).

The cloacal temperatures of the birds and the air temperatures were measured to the nearest tenth of a degree (centigrade) with a mercury thermometer. There were no means of weighing the birds, and, as an indication of relative age, a simple linear measurement was used, namely, from the tip of bill to the end of the pygostyle with the bird in a prone extended position. Temperatures were determined in the middle of the day and again two to three hours after sunset. The birds measured ranged from individuals which were just hatching to those which were almost fully feathered.

Measurements showed that there is a statistically significant correlation between body temperatures and air temperatures. At all times body temperatures were far above those of the environment and, although air temperature varied through more than 13° C., a fluctuation of only slightly more than 6° C. was observed even in the smallest class of gulls.

The fact that the lowest air temperatures occurred at night, which is also the time of minimal activity for the young gulls, made it difficult to assess under field conditions the relative effects of environmental temperature and the diurnal cycle of activity on body temperatures at night.

During the day-time the correlation between body length and body temperature was not significant. This lack of correlation suggests that even the smallest of the nestlings can regulate its temperature adequately in the range of day-time temperatures at which measurements were made. At night the correlation between body length and body temperature was stronger. Data did not indicate, however, whether the night-time body temperatures of the large nestlings were higher than those of the small ones because of a greater relative heat production or because of a smaller relative rate of heat loss associated with their lower surface-mass ratio.

Very small nestlings may compensate in part for their relatively large surface area by a behavioural response. At night in virtually every instance the smaller birds were found "huddling", two or three close together in well-sheltered sites. That the huddling response conserves heat in birds was previously shown by Kleiber and Winchester in 1933, who found that, by huddling together, baby domestic chicks can reduce their metabolic rates as much as 15 per cent.

During the day nestling gulls can supplement metabolic heat by the absorption of radiant energy. Should the heat of the sun become excessive, they may resort to shelter. Nearly all the western gull nests on Santa Barbara Island were at least partly shaded by rocks or vegetation. The sheltered location of young and eggs also afforded considerable protection from the wind. The newly hatched young remain in, or very close to, the nest, while the larger young are less sedentary and in consequence much more exposed to the elements.

During the afternoon the investigators found two "pipped" eggs which, because of their presence in the rookery, had not been incubated for the preceding forty-five minutes. The eggs were opened and cloacal temperatures of the young birds were measured. The hatchlings' temperatures were 32·3° and 33·8° C. and the air temperature was 27° C. The importance of radiant energy in furnishing heat was in this instance reduced by an overcast sky and the shelter supplied by tussocks of grass. These temperature measurements suggest that, in the western gull, as was also shown in the domestic chicken by Romanoff in 1941, some ability to regulate body temperature is present before hatching.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Is there an Æther ?

In *Nature* of November 24, p. 906, Dirac draws an interesting conclusion from his new electrodynamics ; namely, the necessity of a revival of the æther concept. I have some doubts whether such an inference is necessary. Indeed, if we eliminate the coefficient λ from Dirac's equations, we obtain the following system of equations :

$$f_{\mu\nu} = A_{\mu,\nu} - A_{\nu,\mu} \quad (1)$$

$$f\rho^{\nu}{}_{,\nu} \left\{ \delta_{\rho}{}^{\mu} - \frac{A_{\rho}A^{\mu}}{k^2} \right\} = 0. \quad (2)$$

Considering (2) from the algebraic point of view, we see that two cases must be considered :

$$\text{Case (1) : } \det \left| \delta_{\rho}{}^{\mu} - \frac{A_{\rho}A^{\mu}}{k^2} \right| \neq 0. \quad (3)$$

In this case, equations (2) lead to $f\rho^{\nu}{}_{,\nu} = 0$, that is, to Maxwell's equations if charged particles are absent.

$$\text{Case (2) : } \det \left| \delta_{\rho}{}^{\mu} - \frac{A_{\rho}A^{\mu}}{k^2} \right| = 0. \quad (4)$$

Equation (4) means precisely $A_{\mu}A^{\mu} = k^2$. This condition must be fulfilled only if we are looking for a solution for which

$$k^2\lambda = A_{\rho}f\rho^{\nu}{}_{,\nu} \neq 0,$$

that is, if charges are present. Thus (4) need not be fulfilled for a vacuum, or for any regions for which

$$k^2\lambda = A_{\rho}f\rho^{\nu}{}_{,\nu} = 0.$$

As to Dirac's formulation, the replacement of the equation

$$A_{\mu}A^{\mu} - k^2 = 0$$

by

$$\lambda(A_{\mu}A^{\mu} - k^2) = 0$$

leaves all physical conclusions of his electrodynamics unchanged and seems to remove the necessity of reviving the æther concept.

L. Infeld

Institute of Theoretical Physics,
University of Warsaw.
Jan. 31.

Infeld has shown how the field equations of my new electrodynamics can be written so as not to require an æther. This is not sufficient to make a complete dynamical theory. It is necessary to set up an action principle and to get a Hamiltonian formulation of the equations suitable for quantization purposes, and for this the æther velocity is required.

The existence of an æther has not been proved, of course, because my new electrodynamics has not yet justified itself. It will probably have to be modified by the introduction of spin variables before a satisfactory quantum theory of electrons can be obtained from it, and only after this has been accomplished will one be able to give a definite answer to the æther question.

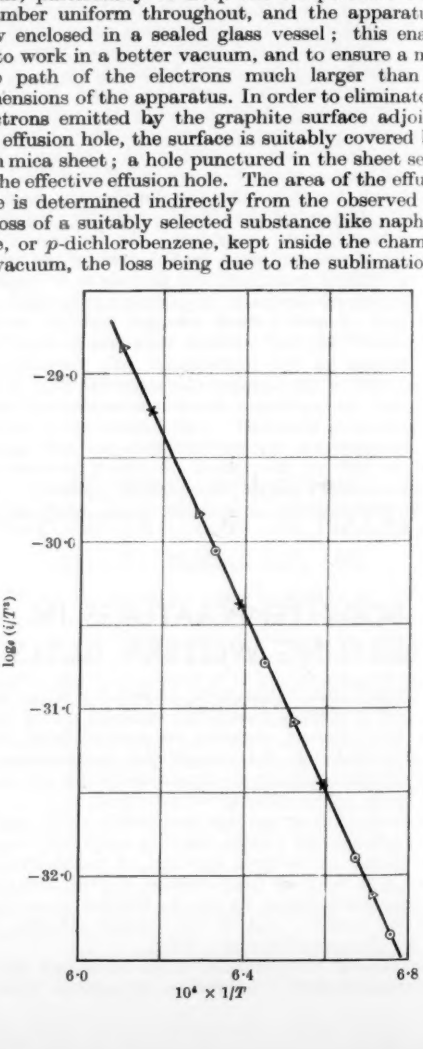
P. A. M. Dirac

St. John's College,
Cambridge.
Feb. 16.

Thermionic Constants of Graphite

Some years ago, one of us (K. S. K.) suggested a new method of determining the thermionic constants of solids. The method is based on the determination of the saturation vapour pressure of the electron gas in equilibrium with the substance at different known temperatures. In practice, this is done by finding the rate of effusion into vacuum of electrons out of a small hole in a thin wall of a chamber scooped out of the substance. Using a well-known thermodynamic relation, analogous to the Clapeyron-Clausius equation connecting the temperature variation of the saturation vapour pressure of a given substance with its latent heat of evaporation, one obtains readily the thermionic constants. The work function of graphite was determined by this method by Dr. A. S. Bhatnagar[1], and of a few other substances by Dr. S. B. L. Mathur[2] ; but the A coefficients in Richardson's equation were not determined by these authors, owing to uncertainties in some of the absolute measurements.

We have now improved the experimental technique, particularly to keep the temperature of the chamber uniform throughout, and the apparatus is now enclosed in a sealed glass vessel ; this enables us to work in a better vacuum, and to ensure a mean free path of the electrons much larger than the dimensions of the apparatus. In order to eliminate the electrons emitted by the graphite surface adjoining the effusion hole, the surface is suitably covered by a thin mica sheet ; a hole punctured in the sheet serves as the effective effusion hole. The area of the effusion hole is determined indirectly from the observed rate of loss of a suitably selected substance like naphthalene, or *p*-dichlorobenzene, kept inside the chamber, in vacuum, the loss being due to the sublimation of



the substance and its subsequent effusion through the hole.

We reproduce in the graph the results obtained in three typical sets of measurements with graphite, in which $\log_e(i/T^2)$ is plotted against $1/T$, where i is the saturation current in amperes corresponding to effusion, per unit area of the effusion hole, in all directions, and T is the absolute temperature. The slope of the curve determines $-\varphi/k$, where k is the Boltzmann constant and φ is the work function, and it is found to correspond to :

$$\varphi = 4{\cdot}62 \pm 0{\cdot}02 \text{ eV.}$$

The intercept of the curve on the y-axis at $1/T = 0$ gives $\log_e A$, from which we find

$$A = 60 \pm 2 \text{ amp. cm.}^{-2} \text{ deg.}^{-2}.$$

This is almost exactly the value that one obtains for good metals.

This method of determining the thermionic constants has certain merits over the usual methods, in that it does not involve a knowledge of the effective area of the emitting surface, which is difficult to determine, or of the reflexion coefficient of the electrons at the surface of emission. Any localized stray impurities in the chamber, as, for example, small bits of copper or zinc deliberately introduced, are found to have no influence on the observation ; this is understandable, since the contact potential between the material of the walls of the chamber and the inserted metal will be almost exactly the difference between their work functions.

K. S. Krishnan
S. C. Jain
National Physical Laboratory of India,
New Delhi.
Nov. 14.

[1] *Proc. Nat. Acad. Sci., Ind.*, A, **14**, 5 (1944).
[2] Doctorate thesis, University of Allahabad ; see also *Proc. Ind. Sci. Cong. Assoc.*, 1950, p. 23.

Study of the Distribution of Surface Potential by means of Radioactive Deposits

Certain radioactive materials can be brought into the gas phase in a charged condition ; for example, a large percentage of the products formed after the decay of the emanations and also some recoil atoms. It was thought that these ions might be suitable particles for tracing electrical or magnetic fields, especially inherent electric fields due to contact potential differences and fields of very small dimensions (where conventional test bodies would disturb the field).

Experiments have been carried out on the study of contact potentials of polished metallic surfaces. A special camera of cylindrical form was constructed containing a radiothorium source (about 0·2 mC.). A uniform electric field can be maintained in the space between the source and a collecting disk (of 2 cm. diameter). After exposure, the disk is removed and an autoradiograph prepared.

It was first shown that disks made of pure metals acquired uniform activity over the surface (apart from some edge effects). Then disks of lead containing rods of different metals were studied. In one experiment the disk was negative with regard to the source, the field-strength being 50 volts/cm. The

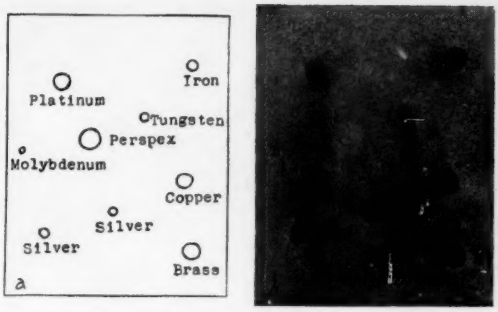


Fig. 1 (*a*). Diagram showing arrangements of rods of various metals in a lead disk
(*b*) Autoradiograph of the same disk after activation in thorium emanation for 24 hr., obtained with Kodak Autoradiographic Plate (ref. 2), mounted on a microscope slide. Exposure 2 hr. Magnification × 3. (Radioactive regions are dark)

autoradiograph showed that metals with a work function higher than that of lead (platinum, silver, molybdenum, iron, copper, brass) had received a larger deposit than lead. The photographic density of the various phases showed a certain correlation to the work function, the present sensitivity permitting observation of differences of 0·1 V. When the field direction was reversed the picture was reversed ; that is, the platinum, silver, etc., phases became less active than the surrounding lead. Working with source and disk at the same potential, we found the distribution of activity (Fig. 1) to be quite similar to the case of the negative disk. The experiments were made at atmospheric pressure.

The probable interpretation is that the positive ions formed in the gas travel along the lines of force and are deposited on the negative disk. Phases having a high work function for electrons are negatively charged with regard to those of low work function[1] ; that is, the electric field-strength is higher in the former case. Therefore, there will be a concentration of positive ions on the phases having high work function, as is observed. The field-strength vector at the surface will be approximately represented by the amount of deposit per unit area (proportional to the photographic density) if the original distribution of radioactive ions near the source was uniform. If the field direction is reversed, the deposit will be concentrated on the phases having low work function. This qualitative interpretation can explain most of the present experimental findings.

If, however, insulating phases are present, another effect appears. In Fig. 1 there is present a 'phase' of an insulator, polyacrylic plastic ('Perspex'), and the autoradiograph shows that it has collected a very low activity. The reason for this is most likely the very high surface resistivity of the plastic material (of the order 10^{14} ohm. cm.). Similar effects have also been observed for other insulators. This 'resistivity effect' is present regardless of the direction of field, in accordance with the above explanation. If the surface resistivity is different, different amounts of deposits are expected.

Applications. Fig. 2 shows an autoradiograph of an exposed mineral section (mineral negative, field strength 50 V./cm.). Here the resistivity effect is very important, making the silicate phases (insulators) almost free from deposits and the semiconductors (lead sulphide, zinc sulphide) activated. It is seen that the deposit on zinc blende is greater

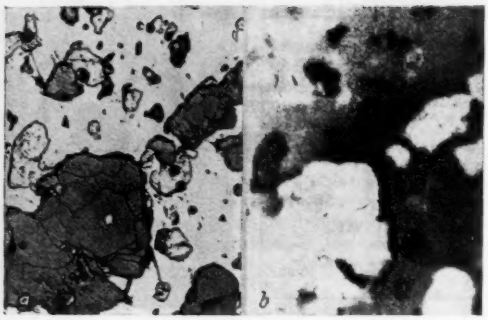


Fig. 2 (*a*). Photomicrograph of mineral containing galena and zinc blende. Magnification × 7
(*b*). Autoradiograph of the same area after activation in thorium emanation for 24 hr., obtained with Kodak Autoradiographic Plate mounted on a microscope slide. Exposure 2 hr. Magnification × 7. (Radioactive regions are dark.) Black areas are zinc blende, grey areas galena and white areas gangue minerals

than that on galena, the reason for this is not yet known.

The method has so far been applied only to a few alloys; but is believed to be of rather general applicability provided the contact potential differences are not too small. Moreover, improvements in sensitivity can probably be made. For accurate physical studies, the main problem is to keep the surfaces uncontaminated, and efforts are now made to meet these requirements.

Radiographs of surfaces of biological materials (such as wood) exposed to radon have been obtained by Jech[3]. It is possible in that case also that electrical charges are responsible for the image formation.

A more complete description of the method will be published elsewhere.

This investigation was supported by the Swedish Atomic Committee. We thank Prof. Ole Lamm for his encouragement and also G. Aniansson, whose investigations on absolute potential measurements gave us the idea of the present method.

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Reverse Thermo-Remanent Magnetism

A large number of experimental investigations has been carried out on the direction of the geomagnetic field in past geological times by means of the remanent magnetization of large masses of igneous rocks[1]. The results showed that many rock masses have remanent magnetism, the direction of which coincides with that of the present geomagnetic field within a few tens of degrees, whereas other rock masses have remanent magnetism the direction of which is almost opposite to the present geomagnetic field. The origin of the remanent magnetism of igneous rocks has been attributed to the thermo-remanent magnetism, chiefly as the result of work by Koenigsberger[2], Nagata[3], Thellier[4], Roquet[5] and Néel[6]. As briefly described in my previous communication, the thermo-remanent magnetism is the result of cooling of rock specimens or of ensembles of grains of ferromagnetic ferrites from a certain high temperature in a magnetic field, and the direction of the thermo-remanent magnetism generally agrees with that of the magnetic field applied during cooling.

In this communication a particular case of thermo-remanent magnetism, the direction of which is opposite to that of the applied magnetic field under certain conditions, will be described. The test samples are ensembles of grains of 'magnetite with impurity' in hypersthene hornblende dacitic pumices, which were ejected from Mt. Haruna in Japan. The chemical composition of this sample is:

Fe_2O_3	:	57·9 per cent
FeO	:	34·7 „ „
TiO_2	:	7·4 „ „

and the mean diameter of these grains is about 0·39 mm.

When this sample is cooled down from 350° C. to room temperature in a magnetic field of 0·5 Oersteds, it takes a remanent magnetism of 0·12 e.m.u./c.c. in intensity, and the direction of the magnetization is opposite to that of the applied field. The remanent magnetization thus produced is quite stable. This fact is a new phenomenon, having quite a different character from the ordinary thermo-remanent magnetism of ferromagnetic ferrites. It will be termed here 'reverse thermo-remanent magnetism', while the ordinary thermo-remanent magnetism will be called 'normal thermo-remanent magnetism'. It may be presumed that some of the reverse magnetization of igneous rocks will be due to the reverse thermo-remanent magnetism mentioned here.

Fig. 1 shows the results of cooling the sample in a partial magnetic field through various temperature ranges. The ordinate in the graph indicates the intensity of remanent magnetization at room temperature after cooling in a magnetic field of 2·0 Oe. in a temperature range of 50 degrees only, which is shown on the abscissa, and then cooling down to room temperature in a non-magnetic space.

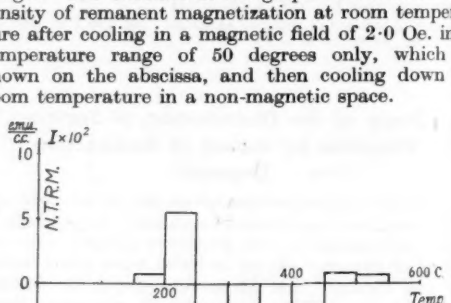

Fig. 1. Partial thermo-remanent magnetism produced by cooling in a magnetic field of 2·0 Oersteds through various temperature ranges. The negative values of *I* indicate the reverse thermo-remanent magnetism

As will be seen in the graph, the reverse thermo-remanent magnetism can be effectively produced by cooling in the temperature range 450–250° C. in a magnetic field. It may be worth while to note here that the addition law for normal thermo-remanent magnetism found by Nagata and Thellier does not hold exactly in the present case.

The production of reverse thermo-remanent magnetism depends on the intensity of the applied mag-

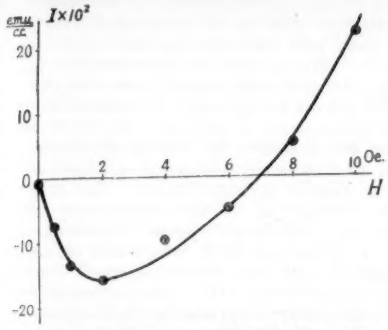

Fig. 2. Relation between the partial thermo-remanent magnetism produced by a magnetic field on cooling from 350° to 250° C., and the intensity of applied magnetic field in that temperature range

netic field. As shown in Fig. 2, it appears only on cooling in a weak magnetic field less than a certain critical value, say, 7·0 Oe. in the present case. Cooling in a magnetic field greater than the critical value produces normal thermo-remanent magnetism.

The cooling of the samples was carried out in a non-magnetic and non-inductive vacuum furnace or in a non-magnetic and non-inductive nitrogen-gas furnace. The results in both cases were the same. The reason why the particular sample concerned has reversed thermo-remanent magnetism has not yet been ascertained. Physically speaking, however, the ferro-magnetism of this ferrite sample may be composed of two different phases; the first phase being predominant at high temperature under the effect of the magnetic field, while the second may be subjected to the demagnetizing field caused by the first one, its spontaneous magnetization being larger than that of the first one at room temperature. An investigation of the physical conditions for producing reverse thermo-remanent magnetism is being undertaken.

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Mechanism of the Arylhydroxylamine and Semidine Rearrangements

IN my presidential address[1] to the Chemical Society in 1941 I discussed the circumstances of the transformation of hydrazobenzene into benzidine, and arrived at the conclusion that the diphenyl link is produced in an essentially homopolar fashion as the result of a summation of electromeric displacements.

The semidine rearrangement, obviously requiring a little more than half of the benzidine arrangement, was also discussed, and the two possible views (*A*) and (*B*) on a polar basis were mentioned. (*A*) was the hypothesis attributed by Heller, Hughes and Ingold[2] to Dewar[3] in so far as it applies to the phenylhydroxylamines, whereas (*B*) was the semidine analogue of the theory of the arylhydroxylamine change, now advanced by the former authors, and also in essential particulars by Braude[4].

However, I saw objections to both (*A*) and (*B*) and preferred for the semidine, as for the benzidine, change a homopolar expression (*C*) compounded of small electromeric changes (*A* and *B*). Even in this case there was a flow of electrons from the *p*-position to the nitrogen atom because, though the displacements in the aromatic nucleus cancel out in the (*A*) type, in (*B*) they are all in the same direction, corresponding to the oxidation of the *p*-position and the reduction of the hydrazine (or hydroxylamine) group.

The question as to whether a rearrangement is intramolecular or intermolecular is, of course, an important and interesting one, but it does not involve any serious decision in regard to fundamental mechanism. Quite naturally, both intramolecular and intermolecular reactions of one and the same basic nature can occur in a given series, for example, the formation of lactones and polyesters in different cases from hydroxy-acids.

It is a very different thing to postulate that some of the acid-catalysed rearrangements, $Ph.NRX \rightarrow X.C_6H_4.NHR$, are anionoid (nucleophilic) and others are cationoid (electrophilic). The analogies appear to be too close to allow of such a *volte-face* with graceful ease.

The difficulty is probably inherent in the present tendency, which I consider retrogressive, to represent all polar reactions of organic compounds as dependent on the development of full ionic charges, even on carbon. It must then be either one thing or the other; ions must be positive or negative.

On the other hand, I have, from the beginning, emphasized my view that electromeric displacements which orientate the initial attack of a reagent are small in amplitude, although there are many examples where a succession of such small displacements occurs in the same direction, and this is equivalent to the intervention of an ion. Even in the aromatic nucleus this is possible, and then we often get a hydroaromatic product which is usually a tender molecule, very prone to further change. In the usual case the nucleus is supposed not to depart far from its normal position and hence the formation of by-products is minimized.

The dilemma presented by the N-substituted anilines was felt in 1941 and led to the overall symmetrical scheme for hydrazobenzene → benzidine. In the case of an unsymmetrical diarylhydrazine, there must be more or less departure from full equivalence of the oppositely polar partial valencies developed in successive phases; but a swing on either side of the zero position offers no philosophical difficulties.

Kinetics of particular processes can only be discussed when the facts are fully disclosed; in many cases dissociation into radicals will give the same results as ionization.

The converse and corollary of our hypothesis that many reactions now illustrated by symbols for ions are actually stepwise, and may even be homopolar when the steps are summed, is that free radicals and atoms can themselves be ranged in order in electropolar series. Relatively to one another they may be classified as anionoid or cationoid, but this refers only to the first phase of a reaction process in which a new covalent link is formed by activity of the odd electrons.

Along these lines the supposed antithesis between homopolar and heteropolar reactions disappears. A more detailed discussion of these aspects of the theory of organic reactions will be submitted elsewhere.

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Jan. 18.

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A New Synthesis of *iso*Flavones

Eighteen different *iso*flavones are known to occur in plants either in the free state or as glycosides; 5 : 7-dihydroxy-4′-methoxy*iso*flavone (I) (biochanin-A) may be taken as a typical example.

Two main methods have been developed for their synthesis. In the first, a deoxybenzoin, for example (II), is converted into a 2-styryl*iso*flavone, either by direct cinnamoylation[1] or by acetylation to a 2-methyl*iso*flavone followed by the condensation of the reactive methyl group with benzaldehyde[2], and, after protecting any free phenolic groups, oxidation by permanganate gives a 2-carboxy*iso*flavone, which is decarboxylated and the protecting groups removed. The yields at the oxidation stage are poor, and the method is not well suited for the preparation of partially alkylated *iso*flavones; it has been used for the preparation of genistein, daidzein and ψ-baptigenin.

In the second, a deoxybenzoin (II) is directly converted into an *iso*flavone by treatment with ethyl formate and sodium. In the early experiments[3], the mixture was heated and the yields were poor; but Venkataraman and others showed[4] that much better results were obtained at 0°. The chief drawback to this synthesis is that it only proceeds satisfactorily if all phenolic groups in the deoxybenzoin, except that involved in the cyclization, are protected by methylation or benzylation, though it has been claimed[5] that the deoxybenzoin (II) is directly converted into the *iso*flavone (I) by this method. We have, however, been unable to prepare (I) in this way, and related reactions involving formylation of deoxybenzoins containing three free phenolic groups have also failed[6]. A modification of this formylation method[7] using ethyl orthoformate in pyridine proceeds satisfactorily in the cases of a 2-hydroxy- and of 2 : 4-dihydroxy-deoxybenzoin, but failed to give an *iso*flavone with 2 : 4 : 6-trihydroxydeoxybenzoin.

We have now developed a new simple *iso*flavone synthesis starting from a deoxybenzoin (II) which gives good yields at all stages, even when several free phenolic groups are present. It is particularly suited for the preparation of partially alkylated *iso*flavones without the necessity of employing devices such as partial protection by benzyl groups, partial methylation or partial demethylation. The new method may be illustrated by the preparation of the *iso*flavone (I). The deoxybenzoin (II), when treated at room temperature with ethyl oxalyl chloride in pyridine, gives directly 2-carbethoxy-5 : 7-dihydroxy-4′-methoxy*iso*flavone (III; melting point, 189 190°; 60 per cent yield). Mild alkaline hydrolysis then gives the corresponding acid (yield, 98 per cent), which loses carbon dioxide at its melting point, giving the *iso*flavone (I), best purified as its diacetyl derivative (yield, 81 per cent). Alkaline hydrolysis then gives biochanin-A. The generality of the method has been established by the preparation of a number of other *iso*flavones, including genistein and ψ-baptigenin.

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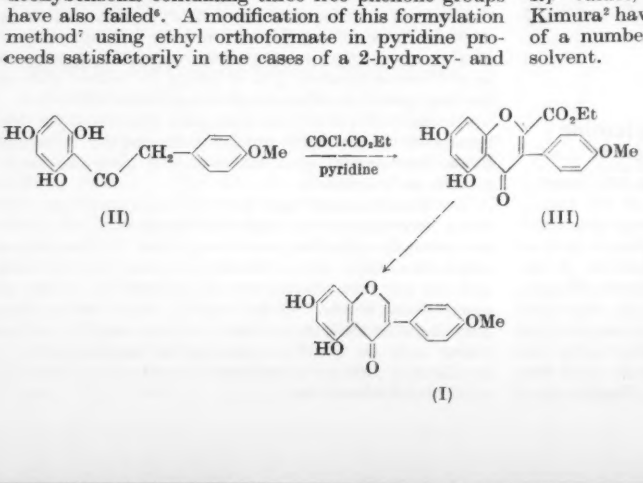

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Separation of the 3,5-Dinitrobenzoates of Volatile Alcohols by Paper Chromatography

Few methods for the separation of derivatives of volatile alcohols by paper chromatography have been reported. Rice, Keller and Kirchner[1] have separated a number of 3,5-dinitrobenzoates by using various solvent systems and filter papers. They quote no R_F values, however. Kariyone, Hashimoto and Kimura[2] have separated the potassium xanthogenates of a number of alcohols, using alkaline butanol as solvent.

The following method for the separation of 3,5-dinitrobenzoates has been of use in the detection of volatile aliphatic alcohols dissolved in benzene or petroleum ether, in quantities greater than 10^{-7} gm. mole. The non-aqueous two-phase solvent system methanol–heptane was used—methanol (commercial absolute), heptane ('fraction from petroleum'). A method of revealing the derivatives, previously used in column separations[3], was adapted for the paper technique. Whatman No. 1 paper, soaked in a methanolic solution of Rhodamine 6 *GBN*.500 (I.C.I., Ltd.), 20 mgm.

per litre, was allowed to drain and dried at 100° C. The benzoates when chromatographed on this paper were revealed in ultra-violet light as dark spots on a yellow fluorescent background, a spot containing 10^{-8} gm. mole being just visible. Spots containing more than 10^{-6} gm. mole tend to overload the paper.

The normal technique of descending irrigation was slightly modified in order to maintain a saturated atmosphere in the chamber with the volatile solvents used. The chamber lid, fitted with a rubber gasket and a thumbscrew tightening device, was completely airtight. Inside were arranged three troughs side by side. From the outer ones were hung large sheets of filter paper.

The benzoates in benzene solution were applied in the normal way to a prepared strip of paper. This was hung from the centre trough at evening and the outer troughs were filled, one with methanol saturated with heptane, the other with heptane saturated with methanol. Next morning the centre trough was filled with the heptane phase through a hole (normally closed) in the chamber lid. The solvent front moves 25 cm. in about one and a half hours.

For the dinitrobenzoates of the following alcohols, R_F values ($\pm$ 0·02) were obtained for a run of about 25 cm. at 20° C.:

Methanol	0·24	2-Butanol	0·61
Ethanol	0·39	2-Methyl-1-propanol	0·55
1-Propanol	0·46	1-Pentanol	0·66
2-Propanol	0·51	3-Methyl-1-butanol	0·65
1-Butanol	0·57	1-Hexanol	0·72

If the values for the homologous series of derivatives of normal alcohols are used for calculating the corresponding R_M values[4] and these are plotted against the number of methylene groups in the alcohols, the points lie approximately on a straight line.

The work described in this communication was carried out as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

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Feasibility of Quantitative Separation of the Threo- and Erythro-Forms of Amino-Acids by Column Chromatography

The methods that are at present available for the separation of the diastereoisomeric forms of amino-acids are subject to several limitations. In the usual fractionation procedures only one of the isomers, at most, is obtained pure, the other remaining contaminated. A high degree of purity is realized only at the expense of yield. The difficulties inherent in isotopic synthesis make the above operations increasingly wasteful, thus further limiting the practicability of these methods.

We wish to report that the application of column chromatography, using an ion-exchange resin ('Dowex-50', 250/500 mesh), led to the clean-cut and quantitative separation of *dl*-threonine and *dl*-allothreonine. On the scale employed (3 m*M*), the chromatographic separation was complete, whereas chemical separation, although yielding microbiologically pure *dl*-threonine, resulted in a *dl*-allothreonine fraction containing much of the threo-form. The carbon-14 labelled products of both chemical and chromatographic separation have been tested for purity by microbiological assay with *L. fœcales*.

The quantitative recovery, the completeness of the separation and the economy of effort resulting from the use of the chromatographic procedure offer great advantages. The investigation is being extended to other β-substituted serines and *iso*leucine. Details of this work will be published elsewhere.

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Counter-Current Distribution of Nisins

It has been suggested[1] that the phrase "100 extractions" quoted from my work by Hirsch[2] is liable to misinterpretation. Amplification is therefore needed.

"Extraction" was used by Bush and Densen[3] to describe the process occurring in each single unit (for example, separating funnel) at each stage of the counter-current distribution. With their technique, n^2 extractions are made in a chain of n units, giving n top layers and n bottom layers. "Extraction" must therefore be distinguished from "transfer".

The technique of Bush and Densen was applied to various samples of nisin, *A* and *L*, mentioned by Hirsch, giving the distribution shown in Fig. 1. Batch 138 is included as an example of a preparation with two active components. "Commercial *B*", different from *B* of batch 138, was distributed earlier by Craig's method[4] in twenty test-tubes (actual number of extractions 210, not 200) and appeared to give two major components, both differing from *A* and *L*; but the measured partition

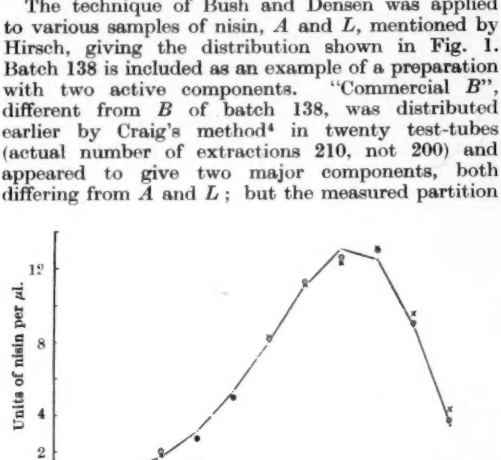

Fig. 1. Distribution of nisins *A* and *L*
-·-·-, Theoretical curve for a single substance; ○, experimental points for *L*; ×, experimental points for *A*

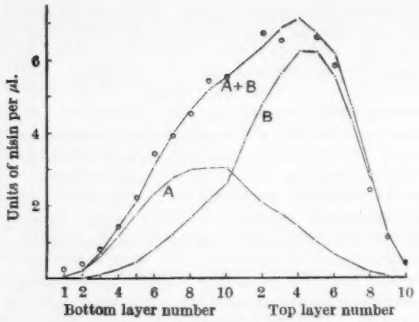

Fig. 2. Distribution of nisins in batch 138
– · – ·, Theoretical curves for two single components and a mixture of them; 30,000 units of *A* and 50,000 units of *B*; ○, experimental points

coefficients were not sufficiently constant to permit a confident analysis of the curve. The solvents were made by adding 40 ml. of glacial acetic acid and 5·44 gm. sodium chloride to 320 ml. of distilled water, adjusting the *p*H to about 3·0 with 10 *N* sodium hydroxide, and adding to this buffer solution 40 ml. of methanol and 200 ml. *n*-butanol. The partition coefficients of the nisins depended upon the *p*H of the buffer.

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Suggested Use of a Bismuth Mercaptoimidazole Compound as a Specific Colour Reagent for Iodides

The reaction of bismuth salts with certain organic thio-compounds, for example, thiourea and dimercaptothiodiazole, to form coloured complexes of the metal is a well-known analytical procedure. Other workers (cf. Naiman[1]) have reported on the detection of bismuth with a mixture of 2-methylbenzothiazole and potassium iodide, which results in the formation of a coloured complex iodide. However, the use of such a reaction for the detection of iodides does not appear to have been reported, probably on the basis of specificity. In certain work on the colorimetric detection of mercaptoimidazoles, I found[2] that the yellow metallic complex, formed by the interaction of bismuth sulphate (acid) and 1-methyl-2-mercaptoimidazole, reacted with iodide ions to form an intensely coloured complex iodide. Since the reaction has been found to be specific for iodides, the use of such a reagent for their detection is suggested.

The colour reagent is prepared by adding 50 mgm. of bismuth sulphate (acid) and 1 ml. of *N* sulphuric acid to 10 ml. of a 0·1 per cent aqueous solution of 1-methyl-2-mercaptoimidazole. After mixing, the undissolved bismuth sulphate is allowed to settle, and the yellow-coloured supernatant fluid used for the test.

The addition of one or two drops of the reagent to a small crystal of an iodide results in the formation of a red coloration, which upon standing or upon agitation forms a red micro-crystalline precipitate. The sensitivity of the reaction is in the region of 100 μgm. Free iodine reacts similarly; but the colour disappears on standing. Iodates and periodates do not react, nor do other metals and radicals. Metals which form insoluble sulphates give a white precipitate. The complex iodide formed in the reaction is practically insoluble in water and dilute mineral acids. As would be expected, oxidizing agents, for example, hydrogen peroxide, liberate iodine from it. When it is prepared in bulk, the red complex exhibits some degree of fluorescence, which is quenched upon shaking the reaction mixture with ethyl acetate, the resulting solution having a yellow colour.

The mercaptoimidazole ring is essential for colour formation. Other thio-compounds such as thiourea do not give the reaction. It would appear that isolation of the yellow bismuth mercaptoimidazole compound would give a much more sensitive reagent, but this has not been carried out here. Other mercaptoimidazoles were examined in this connexion. The 2-mercaptoimidazole, upon reaction with bismuth salts, did not give as sensitive a colour reagent for iodides. Likewise, the 4-aminomethyl-2-mercaptoimidazole reacted with bismuth to give a yellow compound, but this would not react with iodides.

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A New Method for the Degradation of Peptides

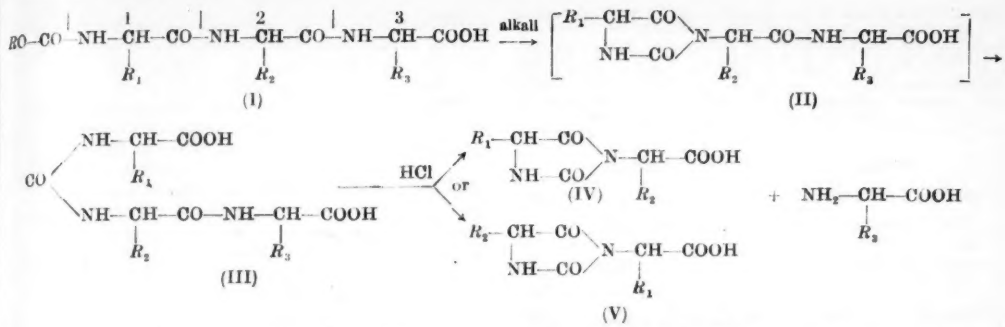
The main problem in working out the structure of peptides is to establish their amino-acid sequence. An essential part of this task consists in determining the amino-terminal and carboxyl-terminal amino-acid residues of the peptide chain (the *amino*-acid and the amino-*acid*)[1]. Many methods are dealing with this problem[2].

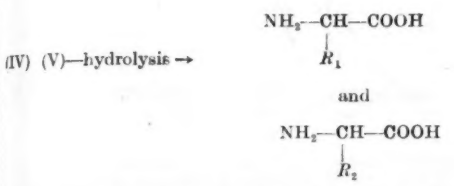
We wish to report a new method, which makes it possible to determine the two terminal amino-acid residues at the amino end (the *amino*-acid and the neighbouring residue) in one procedure. This method is based on former investigations of one of us (F. W.)[3], showing that, on alkali-treatment of N-carbethoxy-dipeptides, a rearrangement takes place leading to the formation of carbonyl-*bis*-amino-acids.

The following scheme pictures the new degradation procedure using a tripeptide as an example.

The peptide is converted into a carbalkoxy-compound (I, $R=CH_3$, C_2H_5 or $C_6H_5CH_2$), which on heating with two moles of dilute alkali gives rise to the urea derivative (III), the hydantoin (II) being probably formed as an intermediate. After treatment with hydrochloric acid, the amino-acids (1) and (2) are easily split off in the form of the hydantoin (IV, V), which may be separated from amino-acid (3)—and the following amino-acids in the case of higher peptides—by means of extraction with ether.

After hydrolysis of the hydantoin (IV, V) the constituent amino-acids (1) and (2) can be identified by paper chromatography. Conversion of the hydantoin (IV) to the acid chloride, reduction of the





latter with sodium borohydride and hydrolysis yields amino-acid (1), detectable by chromatography on paper, and the amino-alcohol corresponding to amino-acid (2), thereby establishing the structure of the hydantoin (IV or V).

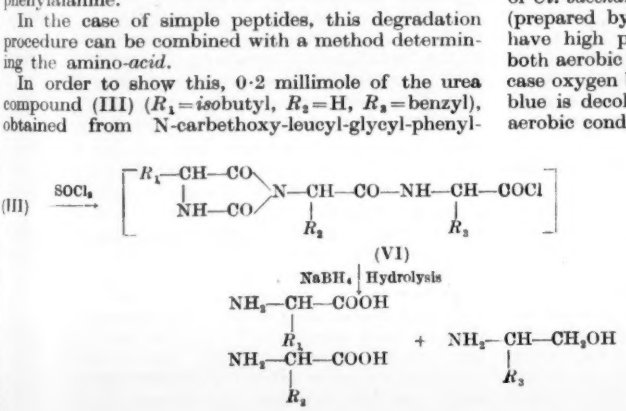
The following peptides were subjected to this degradation and clear results were obtained: diglycyl-glycine, DL-alanyl-glycyl-DL-phenylalanine, DL-leucyl-glycyl-DL-phenylalanine, L-tyrosyl-glycyl-glycine and L-tyrosyl-glycyl-DL-phenylalanine.

In all cases investigated, hydantoins of the general formula (IV) were shown to be formed on acid treatment of the urea compound (III). There is, however, a possibility that with other peptides the ring closure might occasionally proceed in a different way, giving rise to the alternative hydantoin (V); for example, in the case of R_2 being a very bulky group and R_1 being relatively small. If so, the structure of the hydantoin would not be an unambiguous indication for the sequence of the amino-acids (1) and (2), and an alternative method of end-group determination would have to be employed for settling this question.

The method outlined above does not require isolation of the intermediates and may easily be performed on a micro scale, as was shown by using as little as 0·1 millimole of the tripeptide DL-leucyl-glycyl-DL-phenylalanine.

In the case of simple peptides, this degradation procedure can be combined with a method determining the amino-*acid*.

In order to show this, 0·2 millimole of the urea compound (III) (R_1 = *iso*butyl, R_2 = H, R_3 = benzyl), obtained from N-carbethoxy-leucyl-glycyl-phenylalanine, was treated with thionyl chloride; the resulting acid chloride (presumably VI) was reduced by means of sodium borohydride and submitted to hydrolysis. Paper chromatography of the products of hydrolysis revealed leucine and glycine, whereas the amino-*acid* phenylalanine had been reduced to the corresponding amino-alcohol.



We intend to apply this method to other peptides, too, in order to investigate the range of its applicability.

The experimental details of this work will be published elsewhere.

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Coenzyme *A* as a Co-factor of the Pyruvate Dehydrogenase System of *Cl. saccharobutyricum*

IT has previously been shown that cell-free extracts of *Cl. saccharobutyricum GR4* and *Cl. sporogenes GO1* (prepared by disruption in an ultrasonic oscillator) have high pyruvate dehydrogenase activity under both aerobic and anaerobic conditions[1], in the former case oxygen being the hydrogen acceptor. Methylene blue is decolorized during the reaction, even under aerobic conditions.

By modifying the technique of preparing the extracts (omission of catalase and prolongation of the period of disruption[2]), we have obtained extracts without, or with very feeble, pyruvate dehydrogenase activity, as measured by methylene blue reduction, oxygen uptake or liberation of carbon dioxide and hydrogen. However, the pyruvate dehydrogenase activity of a totally inactive extract (IV*B*′) of *Cl. saccharobutyricum* could be fully restored as com-

Table 1. Dependence of the Oxidation of Sodium Pyruvate on the Presence of Coenzyme and Inorganic Phosphate

Each Warburg flask contains 0·5 ml. substrate 0·1 *M* + 1 ml. phosphate buffer *p*H 6·5, 0·2 *M*, or veronal, 0·1 *M*, *p*H 7. In the side-bulb, 0·5 ml. enzyme IV*B*′ = 50 mgm. dry weight. Enzyme and substrate were mixed at $t = 0$. In the centre well, 0·2 ml. of 20 per cent potassium hydroxide. Total volume, 3·2 ml. Experimental time, 120 min. *T*, 37° C. Gas phase, air

Buffer: Veronal			Buffer: Phosphate			
−pyruvate (*μM*)	−oxygen (*μ* atoms)	aceto-acetate (*μM*)	−pyruvate (*μM*)	−oxygen (*μ* atoms)	Aceto-acetate (*μM*)	Oxygen / Pyruv.
0	1	0	0	2	0	
Veronal + 6 u. coenzyme *A*/ml.			Phosphate + 6 u. coenzyme *A*/ml.			
0	1	0	37·8	36	9	0·47
—	—	—	Phosphate + 12 u. coenzyme *A*/ml.			
			42·2	38	10	0·45
—	—	—	Phosphate + 24 u. coenzyme *A*/ml.			
			31·2	32·7	—	0·5

Table 2. Hydrogen and Carbon Dioxide Released from Pyruvate in the Presence of Coenzyme *A* and Inorganic Phosphate

Each Warburg flask contains 0·15 ml. *M*/10 sodium pyruvate + 1 ml. phosphate buffer 0·2 *M*, *p*H 6·5, or veronal buffer 0·1 *M*, *p*H 7. In one side-bulb, 0·5 ml. enzyme (= 40 mgm. dry weight); in the second side-bulb, 0·2 ml. 7·5 *N* sulphuric acid, for stopping the reaction; in the centre well, 0·2 ml. 20 per cent potassium hydroxide, in the flask used for estimation of hydrogen, the flask used for the estimation of carbon dioxide + hydrogen being without potassium hydroxide. Total volume 3·2 ml. Enzyme and substrate were mixed at zero time. Experimental time, 90 min. *T*, 37° C. Gas phase, nitrogen

Buffer	−pyruvate (*μM*)	+ hydrogen (*μM*)	+ carbon dioxide (*μM*)	Hydrogen / Carb. dioxide
Veronal	—	—	—	—
Veronal + 6 u. coenzyme *A*/ml.	—	—	—	—
Phosphate + 6 u. coenzyme *A*/ml.	15	11	13	0·84
Phosphate	2	1·5	2	—

pared with extracts prepared in the normal manner by the addition of a small quantity of an equally inactive extract (17*b*) of *Cl. sporogenes*. The ability of the extract 17*b* to restore the activity of extract IV*B*′ was not destroyed by boiling, and was therefore attributed to the presence of some thermostable factor which was probably destroyed during the disruption of the cells of *Cl. saccharobutyricum*.

Attempts were made to reactivate the extract IV*B*′ with various known co-factors. Coenzyme I and II, an impure preparation of flavine adenine dinucleotide, cocarboxylase (with or without magnesium), adenosine-5-phosphate, adenosine-3-phosphate were all inactive, either when tested singly or in combination. However, the activity was fully restored by a preparation of coenzyme *A* (obtained through the courtesy of Dr. Lipmann).

Further experiments showed that coenzyme *A* was only effective in the presence of inorganic phosphate. Six units of coenzyme *A*/ml. were sufficient for maximum activity as measured by oxygen consumption

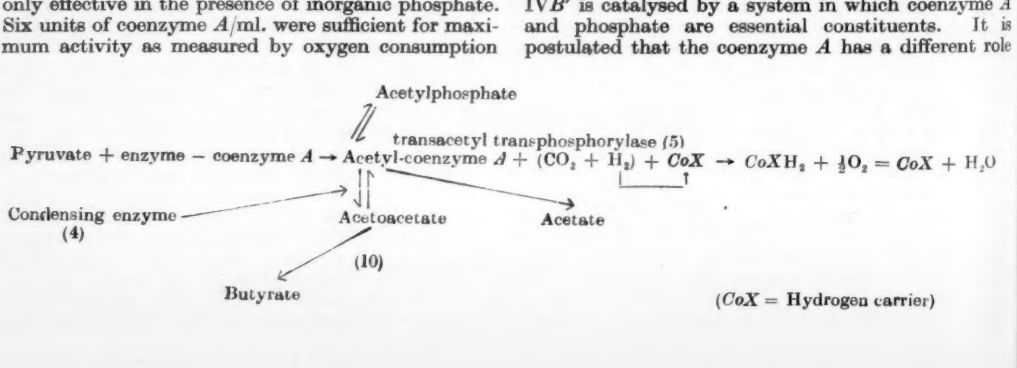
Curve I, oxidation of pyruvate in the presence of 12 units of coenzyme *A*/ml. (50 *μM* sodium pyruvate + 1 ml. 0·2 phosphate buffer *p*H 6·5 + 0·5 ml. enzyme. Total volume, 3 ml.). Curve II, as for curve I, but only 6 units coenzyme *A*/ml. Curve III, as for curve I, without coenzyme *A*. Curve IV, 0·2 *M* veronal replacing phosphate, + 6 units coenzyme *A*/ml.

(Table 1 and graph). The ratio of oxygen consumed to pyruvate metabolized was usually 0·5, but was occasionally somewhat smaller. No acetylphosphate formation could be detected by the method of Lipmann and Tuttle[3]; but our extract did not appreciably destroy a synthetic preparation of acetylphosphate, indicating the probable absence of an acetylphosphatase.

It therefore appeared probable that the acetyl-bound compound formed in the reaction was condensed, through the mechanism described by Chou, Novelli, Stadtman and Lipmann[4] and Stadtman[5], and, in fact, significant amounts of acetoacetate (estimated as acetone) were found to be produced by the complete system: extract + pyruvate + phosphate + coenzyme *A*.

Under anaerobic conditions, only small amounts of the hydrogen liberated, in the pyruvate dehydrogenase system, were used for the reduction of carbon compounds afterwards formed, as shown by the fact that the ratio of hydrogen liberated to carbon dioxide liberated was unity (Table 2).

The complete lack of enzymic activity with the system: extract + coenzyme *A* + veronal buffer + substrate and extract + phosphate + substrate (Table 1) shows conclusively that the major reaction in the oxidation of pyruvate by *Cl. saccharobutyricum* IV*B*′ is catalysed by a system in which coenzyme *A* and phosphate are essential constituents. It is postulated that the coenzyme *A* has a different role



from that of diphosphothiamine in the oxidative decarboxylation (phosphoroclastic reaction) of pyruvate by *Lb. delbrueckii*[6]. In this connexion it is of interest to note that Chantrenne and Lipmann[7] demonstrated partial reactivation of an extract of *E. coli* treated with the anion exchange resin 'Dowex 1' by addition of coenzyme *A*, but hesitated to draw any firm conclusions.

On the other hand, our system differs from that studied by Ochoa *et al.*[8,9] and also prepared from *E. coli*, in which the major reaction in pyruvate oxidation does not appear to require coenzyme *A* (see the scheme presented by Ochoa, p. 74 of ref. 8).

From our results with *Cl. saccharobutyricum*, we postulate the existence of the system shown on p. 710. The absence of the condensing enzyme from this system would probably lead to an accumulation of acetylphosphate, a phenomenon which has, in fact, been observed with our extracts obtained under less rigorously controlled conditions of preparation[1].

This work will be published in detail elsewhere.

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Effect of Amellin in the Prevention of Fatty Infiltration in the Liver

Amellin, which has been found to have beneficial effects in clinical and experimental diabetes[1-3], has recently been observed by one of us (S. P.) in a preliminary investigation on the depancreatized dog to have the property of completely preventing the fatty degeneration of the liver. It was reported earlier by Nath and Brahmachari[4] that amellin (given orally) in the daily dose of 25 mgm. per kgm. can cause considerable desaturation of the liver fat, which according to Schoenheimer and Rittenberg[5] is an indication of increased fat metabolism. Nath and Chakrabarti[3] have also recorded the prevention of tumorous growth in the livers of the animals with acetoacetate-induced diabetes, by simultaneous injection of amellin in a dose of 10 mgm. per kgm. Studies were therefore undertaken to observe the lipotropic effect of amellin in experimental animals.

Montini and Pontremoli[6] have recently observed that, 48 hr. after partial hepatectomy of the rat, the remaining portion of the liver undergoes fatty degeneration with a very large increase in the percentage of fat. This technique was used in this investigation, and experiment was made with sixteen rats, each weighing about 200 gm. Ten animals were used for the experiment and six as control. Amellin was injected intraperitoneally for three consecutive days before partial hepatectomy and for two days more before killing. The results are shown in the accompanying table.

No. of animals	Treatment		Fat in liver just after partial hepatectomy (per cent)	Fat 48 hr. after partial hepatectomy (per cent)	Increase of fat (per cent)
	Substance	Period			
6	nil	—	5·1 ±0·25	8·14±0·31	59·6
6	Amellin inject. (25 mgm./kgm.)	From 3 days before partial hepatectomy	4·91 ±0·15	4·94±0·14	0·6
4	Amellin inject. (10 mgm./kgm.)	,,	4·80±0·14	4·80±0·1	nil

It is thus evident from the results that amellin, which has recently been found to have a thio-methyl pentose as one of its constituents[7], is also lipotropic in nature.

Further investigations are in progress.

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Bacterial Arylsulphatase

When arylsulphatase (phenolsulphatase) acts on the salt of an arylsulphuric acid (for example, potassium phenylsulphate, $C_6H_5OSO_3K$), the substrate undergoes hydrolysis. If the phenolic compound liberated on hydrolysis can be converted to a coloured product, the reaction can be made the basis of a method of detecting the enzyme. Earlier workers, using monoarylsulphates prepared from various phenols as substrates for the detection of arylsulphatase, have shown that this enzyme occurs in plants and animals. Its occurrence in bacteria, however, had not been investigated until recently, when Barber, Brooksbank and Kuper[1] examined 160 strains of *Staphylococcus pyogenes* and 75 strains of coagulase-negative staphylococci for the presence of glucuronidase, phosphatase and arylsulphatase, using the monoglucuronide, diphosphate and disulphate of phenolphthalein as substrates. In only two strains of staphylococci was arylsulphatase detected, although the enzyme was found to be present in an aerobic sporing bacillus encountered as a contaminant and in a strain of *Salmonella paratyphi B*.

In the present investigation, a wide range of bacterial species has been examined for the presence of arylsulphatase, using potassium phenolphthalein disulphate as substrate. This compound has a number of advantages as a substrate; for example, it is stable under conditions used for sterilizing bacterio-

logical media, and very small amounts of phenolphthalein liberated by enzymic hydrolysis can be readily detected by the red colour which is produced on addition of alkali. The potassium phenolphthalein disulphate used in the present work and that used by Barber *et al.* was prepared by two of us (A. R. M. and L. Y.). The synthesis of this compound does not appear to have been described hitherto. It was obtained by allowing phenolphthalein to interact with chlorosulphonic acid in pyridine and chloroform, followed by treatment of the product of this reaction with potassium hydroxide. The potassium phenolphthalein disulphate thus obtained was precipitated with ethanol, and after it had been purified it was obtained as colourless plates from aqueous solution (found : C, 36·7 ; H, 2·9 ; S, 9·8 ; K, 17·0 ; $C_{20}H_{13}O_{11}S_2K_3.2H_2O$ requires C, 37·1 ; H, 2·6 ; S, 9·9 ; K, 18·1 per cent).

To test for the production of arylsulphatase by bacteria, organisms were grown in nutrient broth containing 0·001 *M* potassium phenolphthalein disulphate. After 1, 3 and 7 days incubation at 37° C., *N* sodium hydroxide was added drop by drop to the cultures to detect the presence of phenolphthalein liberated as a result of enzymic activity. Examination of 212 strains of bacteria by this method revealed arylsulphatase activity only in certain strains of salmonellæ and mycobacteria. Among 79 strains of *Salmonella*, no activity was found in nine strains of *Salm. typhi*, whereas all of eleven strains of *Salm. paratyphi A*, eight of twelve strains of *Salm. paratyphi B*, and one of ten strains of *Salm. paratyphi C* showed considerable activity. Among thirty-seven strains of other species of *Salmonella*, twenty-seven strains were found to possess only weak activity and the remainder were inactive under these conditions. Of the ten strains of mycobacteria examined, four strains of *Myco. tuberculosis* (cold-blooded type) were found to possess arylsulphatase, and three of six strains of saprophytic mycobacteria gave positive tests for the enzyme. The medium used in the present work was unsuitable for the growth of other types of mycobacteria, and the examination of mycobacteria requiring special methods for their cultivation is being made part of a separate investigation[2].

Tests were also carried out with 0·001 *M* potassium 1-naphthylsulphate as substrate on 57 strains of salmonellæ and 16 representative strains from other genera. The results obtained with this monosulphate were in general agreement with those obtained with phenolphthalein disulphate.

While a positive finding is significant in tests of this type, a negative finding does not exclude the possibility that an organism produces the enzyme. Variation of the cultural conditions or of the method of testing might reveal the presence of arylsulphatase in an apparently negative organism. It is also possible that some apparently negative strains are able to metabolize the phenolic compound liberated from the substrate, as some bacteria are known to be able to oxidize aromatic compounds under certain conditions[3].

It was found possible to prepare cell-free aqueous solutions of bacterial arylsulphatase. A strain of *Myco. tuberculosis* (cold-blooded type) N.C.T.C. No. 2291 was used as the source of the enzyme. After growth for five to seven days on nutrient broth, the organisms were separated by filtration, dried with acetone, suspended in water and ground with 'Hyflo Super-Cel' in a Potter homogenizer. After more water had been added, the ground material was centrifuged and the supernatant liquid was decanted and filtered through a 'Gradocol' collodion membrane (A.P.D. 0·52 μ) in an Elford ultra-filter. This yielded a clear and almost colourless filtrate with arylsulphatase activity. Tests carried out on this preparation with a substrate of potassium phenolphthalein disulphate showed that the optimum *p*H of the enzyme was 6·3 in phosphate-citrate buffers (McIlvaine series[4]), and that under these conditions the maximum velocity of hydrolysis was reached with a substrate concentration of 0·002–0·003 *M*.

A detailed account of these investigations will be published elsewhere.

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Morphine Antagonism

Two years ago, a report was published[1] by us of some aspects of the pharmacology of morphine. It described what we consider to be a very remarkable example of drug antagonism. Dogs narcotized to the point of unconsciousness with morphine or (more usually) a mixture of morphine (10 mgm./kgm.) and hyoscine (0·6 mgm./kgm.) can be brought to a state of complete and intelligent wakefulness within two minutes of the intravenous injection of the analeptic drug. Since then, we have continued investigating this phenomenon, and have regularly observed this arousal after the injection of a wide series of drugs, including a number not mentioned in the earlier paper.

The analeptic drugs previously reported and the doses used are : aminacrin B.P. salacrin (1-methyl-5-amino-acridine) (5–10 mgm./kgm.) ; rivanol (2,5,diamino-6-ethoxy-acridine lactate) (40 mgm./kgm.) ; 5(ethylamino)-acridine (2·8 mgm./kgm.) ; 1,2,3,4-tetrahydro-5-amino-acridine (5 mgm./kgm.) ; 4-amino-quinoline (5 mgm./kgm.) ; and 2-amino-pyridine (5–12 mgm./kgm.). To these we now add the following highly active drugs : 4-amino-pyridine (3 mgm./kgm.) ; 2,3-diamino-5-phenyl-thiazole (20 mgm./kgm.) ; and the alkaloids eserine (0·25–1 mgm./kgm.) and nicotine (1–2 mgm./kgm.). We were led to try the last two drugs because all the analeptics tested had either a muscarine-like action or were anti-choline esterase drugs. (1,2,3,4-tetrahydro-5-amino-acridine gives almost 100 per cent inhibition at 10^{-6} *M*, and still shows activity at 10^{-9} *M*.) The nicotine action is particularly interesting from a purely theoretical point of view in that, about 30 min. after the arousal, the dog frequently relapses to unconsciousness. This relapse has never occurred with any of the other substances used.

Eserine, the 2- and 4-amino-pyridines, and 2,4-diamino-5-phenyl-thiazole are active when given intramuscularly. The others in the series are not, probably due to binding of the drug by muscle tissue (unpublished evidence in the case of aminacrin). Aminacrin base in propylene glycol has much less activity.

Another important fact noted is the marked (if transient) respiratory stimulation which occurs with most of these drugs, commencing about half to one minute after the injection, that is, before there is any other sign of arousal. This effect is particularly marked in the case of 1,2,3,4-tetrahydro-5-amino-acridine and with a mixture of aminacrin and eserine, and to a slightly lesser degree with aminacrin alone, 4-amino-quinoline, nicotine and 4-amino-pyridine.

The acridines (except rivanol) usually cause a varying degree of excitement. In the case of 5(ethyl-amino)-acridine, this may amount to a prolonged period of extreme panic; with 1,2,3,4-tetrahydro-5-amino-acridine it usually appears only as marked motor activity, sometimes lasting for hours. The latter drug is also notable for the high degree of mental clarity it produces. The dogs which have been aroused by it regularly recognize their names, and come when called.

We feel that the results with these drugs are so clear-cut that a clinical trial is justified in cases of acute morphine poisoning. The analeptics of choice would be, in order of activity, 1,2,3,4-tetrahydro-5-amino-acridine, 4-amino-quinoline, aminacrin, 2,4-diamino-5-phenyl-thiazole and eserine or a mixture of eserine and aminacrin. In our previous paper[1] we have suggested human dosages, on a basis of known toxicities.

Preliminary tests suggest that the action of these analeptics is specific towards morphine (and hyoscine). We have been unable to arouse rats, cats and guinea pigs treated with pentobarbitone. The analgesic action of morphine is also (on rats) unaffected by these analeptics.

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Total Concentration of Fixed Base in Cells of the Renal Cortex of the Rat

Attempts have been made to measure the total concentration of fixed base (sodium, potassium, calcium and magnesium) in the cells of the renal cortex of adult male rats under different conditions. All experiments were carried out with thin slices prepared as for manometric work, and the total concentration of base was determined in portions of moist tissue weighing 300–500 mgm. by the benzidine sulphate method described by Peters and van Slyke[1] for serum. The media used in all these experiments were as described by Robinson[2], and slices which were respiring were maintained at 38° C. in oxygenated solutions in the apparatus described for the "Short Experiments" in the same publication[2].

The total concentration of base in the water in the cells was calculated on the assumption that 26 per cent of the weight of the slices consisted of extracellular fluid having the same ionic composition as the external medium. The accompanying table shows these figures, and also, for comparison, those for the external medium determined by the same method. The average concentration of base in the total water of the tissue was also calculated as a check upon errors which might have been introduced by the somewhat arbitrary division of the water of the tissue between the intracellular and extracellular compartments. The water content of the tissue slices, shown in the last column of the table, gives an indication of their respiration[2], which could not be measured directly.

There was a considerably greater concentration of fixed base within the cells of respiring slices than in the medium; but this difference disappeared when respiration was inhibited by cyanide or by chilling. This might have been due to accumulation of divalent cations within the cells, in which case it need not imply a discrepancy of osmotic pressure. There is, however, no evidence to suggest that divalent ions are accumulated to a sufficient extent to account for the observed differences in concentration between the interior and the exterior of the cells. Analyses made by McCance and Widdowson[3] suggest that the kidneys of sheep and oxen contained only about one-half as much calcium and magnesium as their muscles. In the absence of information about the *p*H inside the cells and about the iso-electric points of their proteins, it is not known how much base might be held inside cells by protein anions which themselves make little contribution to osmotic pressure. Further, if base exists in cells in forms of combination which render it osmotically inactive, it is not easy to see

Total Concentration of Fixed Base in Kidney Slices under Different Conditions

Experimental conditions	(*A*) Total base in external phase (mEq./l.)	(*B*) Total base in cell water (mEq./l.)	(*B*—*A*) Difference (mEq./l.)	(*C*) Total base in tissue water (mEq./l.)	(*C*—*A*) Difference (mEq./l.)	Water content of slices (%)
Respiring at 38° C. in isotonic (0·30 osM) media. Oxygenated. Average of 12 experiments	146	178·5	32·5	168	22	77·0
Isotonic media chilled to ice temperature	148 149	148 153	0 4	148 151	0 2	80·8 80·9
Isotonic media. 38° C. 4 experiments with decreasing concentrations of cyanide in the medium (*M*/200 max.)	148 148 149 149	146 155 155 159	−2 7 6 10	147 153 153 156	−1 5 4 7	84·2 81·2 80·3 79·6
Respiring at 38° C. in hypotonic media (0·17 osM approx.)	87 82	126 117	39 35	110 104	23 22	79·1 79·1
Hypotonic media chilled to ice temperature	70 67	84 82	14 15	80 79	10 12	85·9 84·5
Hypotonic media at 38° C. with *M*/200 cyanide	80 76	98 91	18 15	94 89	14 13	85·1 85·1

why these combinations should be broken down by chilling or by cyanide, or how they could be stabilized by respiration.

There remains the possibility that the excess concentration of fixed base found in respiring cells does imply that the intracellular fluids are hypertonic, as was postulated in my earlier paper[2]. This would readily account for the abolition of the difference in concentration between the cells and their surroundings by cyanide or by chilling. Such a difference in concentration could not be produced by active transport of ions into the cells, for this would merely cause them to swell as a result of the entry of water to equalize osmotic pressure. Since the cells swell when their respiration is inhibited, active transport carried out at the expense of energy derived from respiration must on balance be directed outwards. Moreover, if the result is to leave a higher concentration inside the cells than outside them, there must be a net outward transport of water.

The magnitude of the excess concentration of fixed base inside respiring cells is not sufficient to prove the hypertonicity of the intracellular fluids; but the dependence of this excess concentration upon respiration does suggest that it might arise from active transport of water outwards across the cell membranes.

J. R. Robinson

Department of Experimental Medicine,
Cambridge.
Nov. 29.

[1] Peters, J. P., and van Slyke, D. D., "Quantitative Clinical Chemistry", 2, "Methods" (London: Baillière, Tindall and Cox, 1932).

[2] Robinson, J. R., *Proc. Roy. Soc.*, B, **137**, 378 (1950).

[3] McCance, R. A., and Widdowson, E. M., "The Chemical Composition of Foods". M.R.C. Spec. Rep. 235, 2nd edit. (H.M.S.O., London, 1946).

Preservation of Cytological Material by Storage at or below — 10° C.

It may be of interest to other cytologists and cytotaxonomists to know that anthers and sporangia fixed in 3 : 1 absolute alcohol : glacial acetic acid, and 4 : 3 : 1 chloroform : absolute alcohol : glacial acetic acid, and stored in a deep-freeze 'Frigidaire' cabinet maintaining a temperature between — 10° and — 14° C., produce as good cytological preparations using the aceto-carmine squash technique after six months as freshly fixed material.

Good results have been obtained with *Primula*, *Listera*, various members of the Cyperaceæ (including *Carex*, *Scirpus* and *Schœnus*), Gramineæ, and several ferns. These were fixed for chromosome counts and morphology at meiosis in the pollen mother cells and spore mother cells respectively.

It is especially interesting that material should remain in good condition at — 10° C., as I have never succeeded in making satisfactory preparations from fixations kept in an ordinary refrigerator running at about 4° C. for more than five or six weeks.

E. W. Davies

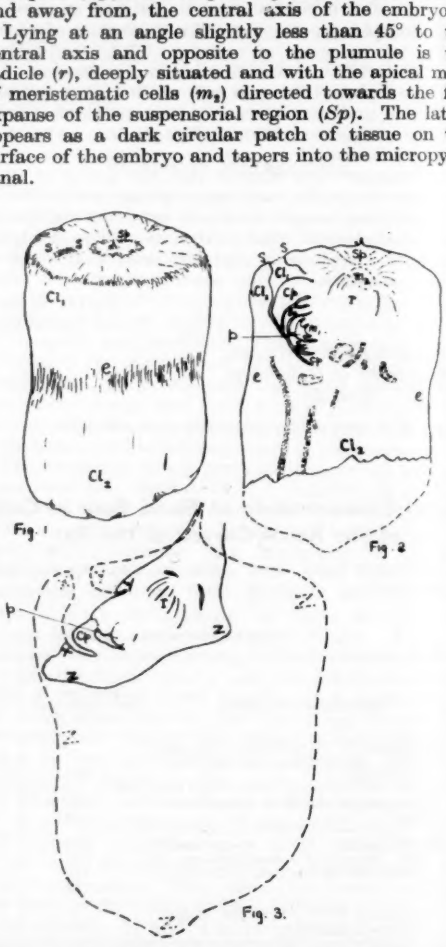
Department of Botany,
University College of Leicester.
Nov. 26.

Embryo of the Coconut

Very little information is available, in the literature, on the embryo of coconut. The family Palmæ, to which the genus *Cocos* belongs, has not been studied embryologically[1].

The mature embryo is somewhat cylindrical in shape and is situated in the endosperm below the 'soft eye', where the sclerotic endocarp is thin. The bulk of the embryonic tissue (Figs. 1 and 2) is made up of the cotyledon, part of which (Cl_1) extends laterally over and envelops the plumule, and is marked off by a slight constriction (at *e*) from the rest, which functions as the haustorium (Cl_2). The region of incomplete fusion of the cotyledon edges above the plumule appears as a radial slit ($S-S$) on the surface of the embryo lying against the sclerotic layer. The entire cotyledon is traversed by vascular strands. The plumule (*p*) in section (Fig. 2) shows a central meristematic zone (m_1) surrounded by the scale-leaf primordia (*Sc*), which in turn are enclosed by the coleoptile (*Cp*). It occupies a position transverse to, and away from, the central axis of the embryo.

Lying at an angle slightly less than 45° to the central axis and opposite to the plumule is the radicle (*r*), deeply situated and with the apical mass of meristematic cells (m_2) directed towards the flat expanse of the suspensorial region (*Sp*). The latter appears as a dark circular patch of tissue on the surface of the embryo and tapers into the micropylar canal.



Figs. 1 and 2. Entire embryo and longitudinal section of embryo of *Cocos nucifera*. (× 6)

Fig. 3. Longitudinal section of *Cocos* embryo (dotted lines), referred to a similar section of embryo of *Poa annua* (continuous lines), after Johansen (ref. 1, Fig. 74, p. 269)

At the commencement of germination, contrary to the usual description[2], the proximal region (*e*) of the cotyledon elongates and the enveloping portion of the cotyledon is forced through the 'soft eye', while the plumule and radicle remain enclosed. This portion of the embryo outside the endocarp enlarges, and the plumule then breaks through the cotyledon to develop into the shoot, while the radicle emerges after a few weeks as the first root.

This embryo is comparable to that typical of the family Gramineæ (Fig. 3). It may be considered as having been derived from the latter, by the scutellum (*X*) and the epiblast (*Y*) extending over the plumule and tending to fuse completely, while the haustorial region (*Z*) extends into the endosperm to increase the surface of absorption.

It is hoped to publish an account of the mature embryo-sac and the development of the embryo, as work on these is under way.

I should like to thank Prof. I. V. Newman for directing my attention to this problem.

E. M. Selvaratnam

Department of Botany,
University of Ceylon,
Colombo.
Nov. 12.

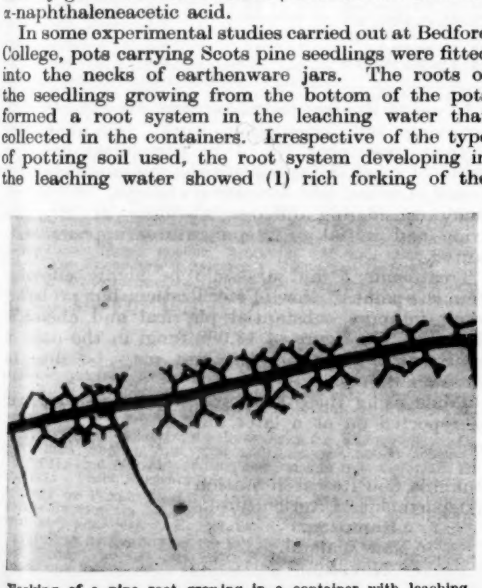
[1] Johansen, D. A., "Plant Embryology", 252 (Waltham, Mass.: Chronica Botanica Co., 1950).

[2] For example, Sampson, H. C., "The Coconut Palm", 78 and 79 and Plates XX *A* and *B* (London: John Bale, Sons and Danielsson, Ltd., 1923).

Forking in Pine Roots

Forking of the short-root system of pine is frequent in Nature and is known to be due to the influence of mycorrhizal mycelia and probably also to certain other types of root fungi. Slankis[1] has demonstrated that in excised pine roots growing in a nutritive solution, forking can be produced by exudates of mycorrhizal fungi (for example, species of *Boletus*) and by growth substances like β-indoleacetic acid and α-naphthaleneacetic acid.

In some experimental studies carried out at Bedford College, pots carrying Scots pine seedlings were fitted into the necks of earthenware jars. The roots of the seedlings growing from the bottom of the pots formed a root system in the leaching water that collected in the containers. Irrespective of the type of potting soil used, the root system developing in the leaching water showed (1) rich forking of the short roots (see accompanying photograph) when the seedlings in the pots had formed mycorrhizas, (2) no forking when the seedlings in the pots possessed no mycorrhizal associations. None of these container roots exhibited any trace of mycorrhizal or other infection. It would appear that the forking is induced by exudates of the mycorrhizal fungi in the potting soil washed into the containers. (So far there is no indication that other washings from the soil are responsible for the forking.) These results conform with Slankis's observations on excised roots.



Forking of a pine root growing in a container with leaching water (× 2)

A further point of interest is that in some experiments in which plants with intracellular (haustorial) infection were used, the container roots were forked and possessed infection of the haustorial type.

Ida Levisohn

Bedford College,
(University of London),
Regent's Park,
London, N.W.1.
Dec. 3.

[1] Slankis, V., *Physiol. Plant.*, **1**, 390 (1948); *Svensk. Bot. Tidskr.*, **43**, 603 (1949); *Physiol. Plant.*, **3**, 40 (1950).

Effect of Adding Penicillin to Turkey Starter Mash

Following reports by Stokstad and Jukes[1] that the addition of aureomycin to the diet of chicks stimulated growth, and by Whitehall *et al.*[2] and Groschke and Evans[3] that other antibiotics had a similar effect, it has now become almost universal practice in the United States to supplement the starter mash of chicks and turkeys with one or other of these agents. In Great Britain, Coates *et al.*[4] confirmed that growth stimulation occurs in chicks and discussed the possible mode of action of the antibiotic.

The importance of rapid growth in table poultry, perhaps more particularly in turkeys, will be readily appreciated, and since, generally speaking, the weights of growing turkeys obtained in Britain compare unfavourably with those of birds of the same age reared under American conditions, it was decided to try the effect of the addition of penicillin to the starter diet.

Crystalline penicillin (sodium salt) was added at the rate of 12·6 gm. per ton to a standard turkey-rearing mash. Feeding, which was *ad lib.*, commenced at a day old and was continued for twelve weeks. In this particular series of experiments, five groups of approximately fifty turkeys were used. These were hatched at different dates throughout the summer; at the time of writing, the oldest are 21 weeks. A similar number of turkeys were kept as controls under identical conditions.

A very striking increase in growth-rate occurred in every group of treated birds. At four weeks the average weights were 1·26, 1·24, 1·12, 1·02 and 0·84 lb., compared with 1·03, 0·87, 0·64, 0·79 and 0·61 lb. respectively in the control groups.

This improvement was observed in all groups throughout the experiment and continued after the feeding of penicillin was stopped. In the oldest group of treated birds at 20 weeks, the heaviest stag was 20·75 lb. and the average weight was 16·4 lb., compared with a heaviest weight of 16·25 lb. and an average weight of 14·7 lb. in the comparable control pen. The average weight of hens was 12·1 lb.

and 11·5 lb. respectively. These improved weights are comparable to those recorded in the United States.

The difference in appearance and behaviour of the poults receiving penicillin was most striking, particularly during the first two to three weeks of life. There was a very obviously increased metabolism. Birds were more active and had much greater vitality. They consumed more food and spent less time in the heated compartment of the brooder. There was a marked difference in mortality and later, at the fifth to sixth weeks, when birds were exposed to natural infection with coccidia, the death-rate was practically nil and the growth-rate was only slightly slowed. In the control pens there was considerable mortality, and growth practically ceased for a week or more. Further experiments are in progress to confirm the latter findings.

The experiments briefly summarized show that the addition of small amounts of penicillin to the diet of growing turkeys not only produced a significant increase in growth-rate but also that it appeared to have a profound effect in stimulating metabolism, tiding chicks over a critical period of susceptibility to chilling and other non-specific causes of mortality during the first few weeks of life. It is too soon to make definite claims concerning a possible effect in increasing resistance to coccidiosis, but preliminary results are suggestive.

Rate of growth and mortality during rearing are factors of primary economic importance to the turkey industry and largely determine the profitability of the undertaking. The success obtained with penicillin suggests that its more general use would be highly beneficial. There may be objections to feeding it to future breeding stock; but its administration to birds destined for the table within the shortest possible time would appear to be strongly indicated.

J. E. Wilson

Ministry of Agriculture and Fisheries,
Veterinary Laboratory,
Eskgrove,
Lasswade, Midlothian.
Nov. 29.

[1] Stokstad, E. L. R., and Jukes, T. H., *Proc. Soc. Exp. Biol.*, **73**, 523 (1950).
[2] Whitehall, A. R., Oleson, J. J., and Hutchings, B. L., *Proc. Soc. Exp. Biol.*, **74**, 11 (1950).
[3] Groschke, A. C., and Evans, R. J., *Poult. Sci.*, **29**, 616 (1950).
[4] Coates, M. E., Dickinson, C. D., Harrison, G. F., Kon, S. K., and Mann, M. E., Proc. IX World's Poultry Congress, **2**, 161 (1952).

Ethylene Oxide for Soil Sterilization

Ethylene oxide has been used for soil sterilization by introducing it under reduced pressure to containers holding the soil in pots or trays. Results have been satisfactory so far as sterilization is concerned, and there appears to be a minimum change in chemical and physical properties of the soil, though certain changes have been reported[1].

Where a large number of pots has to be treated, this method may be time-consuming, and in view of the physical properties of ethylene oxide (solubility in water and boiling point 12·5° C.) it was considered that a more speedy method could be developed.

Essentially the method consists of making up an aqueous solution to supply 2 or 4 c.c. of ethylene oxide in a given amount of water, using pre-chilled glassware and water. The container holding the soil is then watered with the solution and covered. In this trial, 1-lb. honey cartons were used (dimensions: base 2·5 in., height 4·0 in., top 3·5 in.) containing about 400 gm. of soil, and 100 c.c. of 2 and 4 per cent solutions of ethylene oxide applied. The containers rested in a Petri plate bottom and were covered with a top. A fair seal was formed in this manner, and if necessary could be improved by the use of a little petroleum jelly around the edge of the pot.

Amounts of water used must be found by trial beforehand according to the initial moisture status of the soil. The soil used in these experiments was a light sandy loam sieved through a ¼-in. mesh and thoroughly mixed.

The following methods were used and replicated five times, a bulked sample being used for microfloral counts: (1) control; (2) 100 c.c. of 2 per cent ethylene oxide watered on chilled soil and returned to the refrigerator for 12 hr.; (3) 100 c.c. of 4 per cent ethylene oxide watered on chilled soil and returned to the refrigerator for 12 hr.; (4) 100 c.c. of 2 per cent ethylene oxide watered on to soil at room temperature and left for 12 hr.; (5) autoclaved at 15 lb. for 20 min.: (6) sterilized in an electric sterilizer (10 kilos of soil were put in a box with a tight-fitting lid with aluminium electrodes 14 in. × 10 in. separated by 5½ in. This was operated from a 230-V. A.C. current supply. The soil was moistened and after three hours the temperature had reached 95° C., when the sample was taken).

For testing purposes 10 gm. of soil was taken and diluted to 1/20,000 for fungal counts and 1/100,000 for bacterial and actinomyces counts, three parallel plates being used for each count. Some results are printed in the accompanying table.

Treatment	Fungi (thousands)	Bacteria (millions)	Actinomyces (millions)
1. Control	230	4·3	4·7
2. 2 c.c. chilled soil	13	1·8	1·8
3. 4 c.c. chilled soil	0	0·1	0·2
4. 2 c.c. room temp. soil	0	0·3	0·2
5. Autoclaved	13	0·0	0·03
6. Electric sterilizer	0·0	0·0	0·0

It would appear, therefore, that for experiments involving soil inoculation work, this modified method (treatment No. 4 in particular) has the merits of speed and simplicity and minimum changes in soil chemical and structural changes. A further study considering different amounts of ethylene oxide and initial soil temperatures appears warranted.

Treatments 5 and 6 should be highly effective from the point of view of sterilization, but probably result in more substantial physical and chemical changes. The figure of 13,000 fungi in the case of treatment 5 appears high and may be due to contamination.

Trials using these soils are in progress and will be reported on at a later date.

R. E. Rose
R. W. Bailey

Rukuhia Soil Research Station
(Department of Agriculture),
Hamilton,
New Zealand.
Nov. 20.

[1] Clarke, F. E., *Soil Sci.*, 345 (Nov. 1950).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, April 28

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Prof. John T. Edsall (**Harvard**): "Chemical Structure, Interaction and Fractionation of Proteins".* (Further Lectures on May 5, 12, 19 and 26.)

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. K. R. Popper: "Scientific Origins of some Philosophical Problems".

UNIVERSITY OF LONDON (at Birkbeck College, Malet Street, London, W.C.1), at 5.30 p.m.—Prof. H. S. M. Coxeter, F.R.S.: "Non-Euclidean Networks and Quadratic Forms, 1, Non-Euclidean Geometry".* (Further Lectures on April 30 and May 2.)

Monday, April 28—Saturday, May 3

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2).—Convention on "The British Contribution to Television".

Tuesday, April 29

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Mr. Stephen Morris: "Rank and Class in a Sarawak Village".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. D. O. Hebb (**McGill**): "The Development of Perception and Thought".* (Further Lectures on April 30 and May 2.)

SOCIETY OF INSTRUMENT TECHNOLOGY (joint meeting with the CONTROL SECTION, at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Dr. W. E. Hick: "Why the Human Operator?"

Wednesday, April 30

UNIVERSITY OF LONDON (at the Royal Veterinary College, Royal College Street, London, N.W.1), at 4 p.m.—Prof. C. Romijn (Utrecht): "Problems of Respiration and Heat Regulation in Domestic Animals, especially in Poultry".* (Further Lectures on May 1 and 2.)

WOOL EDUCATION SOCIETY (at the Royal Institution, Albemarle Street, London, W.1), at 7 p.m.—Dr. Allan Fraser: "Sheep Husbandry and Wool Growing in Britain".

UNIVERSITY OF LONDON (at the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1), at 8.15 p.m.—"Archæology and the Natural Sciences, 1, Archæology and Geology".* (Further Lectures on May 7, 14, 21, 28, June 4 and 11.)

Wednesday, April 30—Thursday, May 1

IRON AND STEEL INSTITUTE.—Annual General Meeting.

Wednesday, April 30

At 11.45 a.m. (at the Royal Institution, 21 Albemarle Street, London, W.1).—Prof. E. N. da C. Andrade, F.R.S.: "The Flow of Metals" (Sixth Hatfield Memorial Lecture).

At 2.30 p.m. (at 4 Grosvenor Gardens, London, S.W.1).—Discussion on "Cold Rolling"; at 4 p.m.—Discussion on "Softening of Metals during Cold Work".

Thursday, May 1

At 10 a.m. (at 4 Grosvenor Gardens, London, S.W.1).—Discussion on "Open-Hearth Furnace Combustion Problems"; at 11.45 a.m.—Discussion on "Air Filtration and Roof Wear in Open-Hearth Furnaces"; at 2.15 p.m.—Discussion on "Hydrogen in Steel".

Thursday, May 1

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 10.30 a.m.—**Discussion on "The Structure of Proteins".**

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. R. G. Jarvis: "The Railways and Coal".*

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. C. W. Allen: "The Framework of Astronomy" (**Inaugural Lecture**).*

BRITISH GLACIOLOGICAL SOCIETY (in the Department of Geography, Downing Place, Cambridge), at 8.15 p.m.—Mr. Maynard M. Miller: "The Juneau Ice Field, Alaska".

Friday, May 2

CHEMICAL SOCIETY, NEWCASTLE AND DURHAM SECTION (in the Chemistry Building, King's College, Newcastle-upon-Tyne), at 5.30 p.m.—Dr. J. S. Anderson: "Recent Advances in the Chemistry of the Heaviest Elements" (Bedson Club Lecture). (All Fellows are invited.)

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. Robert Ashman: "The Control and Recovery of Dust and Fume in Industry"; Dr. H. Heywood: "Filter Efficiency and Standardization of Test Dust".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, SCOTTISH SECTION (in the North British Hotel, Princes Street, Edinburgh), at 7 p.m.—Mr. J. K. McLellan: "Chemistry and the Law".

UNIVERSITY OF LONDON (at the Royal Holloway College, Englefield Green, Surrey), at 8.15 p.m.—Mr. F. Kingdon-Ward: "Botanical Explorations in Assam". (Admission by invitation from the Principal.)

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. W. D. Wright: "New Studies on Defective Colour Vision".

Friday, May 2—Saturday, May 3

PHYSICAL SOCIETY (in the Department of Physics, Birkbeck College, Malet Street, London, W.C.1).—Symposium on "Recent Developments in the Field of X-Ray Physics".

Saturday, May 3

BRITISH PSYCHOLOGICAL SOCIETY EDUCATION SECTION (in Room 151, Institute of Education, Malet Street, London, W.C.1), at 2.30 p.m.—Dr. C. Sanders: "Selection for Australian Universities—a Review of Research".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT EXPERIMENTAL OFFICER at the Animal Research Station of the Agricultural Research Council's Unit of Animal Reproduction at Cambridge—Dr. A. Walton, Animal Research Station, Huntingdon Road, Cambridge (May 3).

BIOCHEMIST for duties in the Group Pathological Laboratory—The Group Pathologist, Kingston Hospital Pathological Laboratory, 37 Coombe Road, Kingston, Surrey (May 3).

SENIOR LECTURER IN METALLURGICAL ANALYSIS to Honours B.Sc. (Metallurgy) standard—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (May 3).

SENIOR LECTURER IN PRODUCTION ENGINEERING—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (May 3).

SENIOR SCIENTIFIC TECHNOLOGIST (Ref. TT/449) to take charge of the analytical work of the laboratory, and well experienced in fuel analysis, and SCIENTIFIC TECHNOLOGISTS (chemists or physicists, preferably of degree standard, and trained in fuel analysis) (Ref. TT/456), in the Carbonization Department of the Central Research Establishment at Stoke Orchard, Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting the appropriate Ref. No. (May 3).

PRINCIPAL OF THE MUNICIPAL TECHNICAL COLLEGE—The Director of Education, Education Office, St. Helens (May 9).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, University College, Cathays Park, Cardiff (May 10).

CHEMIST (Ref. TT.455) (with a good honours degree or equivalent qualification) for analytical investigational work, a SENIOR SCIENTIFIC TECHNOLOGIST (Ref. TT.456) (with a good general training in chemistry up to degree standard and experience in organizing and supervising the work of a laboratory), and a SCIENTIFIC TECHNOLOGIST I (Ref. TT.457) (with a good general training in chemistry, preferably up to degree standard), in the Coal Survey Laboratory at Birmingham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting the appropriate Ref. No. (May 10).

EXPERIMENTAL OFFICER at the Food Investigation, Torry Research Station, Aberdeen, to assist in physical research, both fundamental and applied, related to the processes of curing, drying and freezing of biological material—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.116/52A (May 10).

SENIOR LECTURER or LECTURER IN CHEMISTRY, and a SENIOR LECTURER or LECTURER IN ZOOLOGY, at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 15 Victoria Street, London, S.W.1 (May 10).

READERSHIP IN ANATOMY at the Royal Free Hospital School of Medicine—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 12).

BIOCHEMIST (with a Medical degree or a Master of Science degree with biochemistry as a major subject and at least 5 years experience in a biochemical department of a large hospital, University medical school or research institute) to supervise the routine biochemical work of the Royal Perth Hospital and associated hospitals, to carry out the more specialized types of biochemical investigations such as hormone assays and to undertake research in such problems—The Agent-General for Western Australia, Savoy House, 115–116 Strand, London, W.C.2 (May 15).

LASDON RESEARCH FELLOWSHIPS in the chemotherapy of tuberculosis (one in chemistry and one in bacteriology or biochemistry)—The President, University College, Dublin (May 15).

LECTURER IN AGRICULTURAL CHEMISTRY, and a LECTURER IN PEDOLOGY—The Registrar, Wye College, Wye, Ashford, Kent (May 15).

PSYCHOLOGISTS in the Admiralty, War Office, and Prison Commission—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 75/52 (May 15).

LECTURER IN TAXONOMY—The Secretary, The University, Birmingham 3 (May 17).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (Entomologist) IN THE DIVISION OF ENTOMOLOGY, Canberra, to work on biological control, with particular reference to weeds—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3707 (May 17).

GEOLOGISTS under the Department of Scientific and Industrial Research (to field and laboratory posts in connexion with radioactive mineral investigation (qualifications in mineralogy, petrography or mining geology being essential) and to the Geological Survey and Museum, palæontological, geophysical or field staff)—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.168/52 (May 22).

TECHNICAL ASSISTANT (with a University degree in engineering or science or equivalent qualifications, together with knowledge of and practical experience in control of work in the fields of geodesy applied to mapping and aerial navigation, map construction and cartography, process photography and lithographic reproduction) to the Head of Establishment at the Air Ministry Survey Production Centre, Feltham—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4137/52 (May 22).

CHAIR OF ANATOMY, and the CHAIR OF HISTORY, in the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 31).

CHAIR OF CHEMISTRY in University College, Ibadan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 31).

ENTOMOLOGISTS (with a degree in zoology and a sound knowledge of entomology and botany) to carry out a survey of the tsetse areas of the Sudan and undertake research work—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Entomologist, 4/2204' (May 31).

LECTURER IN PHYSICS at Rhodes University, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 31).

SENIOR LECTURER, LECTURER OR ASSISTANT LECTURER IN MATHEMATICS, and a LECTURER IN SOIL SCIENCE, at University College, Ibadan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 31).

LECTURER IN THE ELECTRICAL ENGINEERING DEPARTMENT—The Head of the Electrical Engineering Department, City and Guilds College, Exhibition Road, London, S.W.7 (June 1).

LECTURER OR ASSISTANT LECTURER IN THE DEPARTMENT OF OCEANOGRAPHY—The Registrar, The University, Liverpool (June 3).

FOOD INDUSTRY RESEARCH STUDENTSHIP—The Secretary, Queen's University, Belfast (June 21).

PROFESSOR OF ORGANIC CHEMISTRY in the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 30).

RESEARCH STUDENTSHIPS IN SCIENCE—The Registrar, The University, Manchester 13 (July 1).

ASSISTANT (Grade A) FOR MATHEMATICS, and an ASSISTANT (Grade A) FOR PHYSICS—The Principal, Technical College, Queen Street South, Huddersfield.

ASSISTANT PROFESSOR IN ELECTRICAL ENGINEERING (qualified to teach courses in servomechanisms and industrial electronics, and to supervise the laboratories in these subjects)—Prof. G. F. Tracey, Electrical Building, University of Toronto, Toronto 5, Ont., Canada.

CHEMIST in the East African Hides, Tanning and Allied Industries Bureau, East Africa—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. 27106/56/52.

COMPUTORS IN THE SURVEY DEPARTMENT in Tanganyika, to undertake computation of geodetic, astronomical and cadastral surveys and preservation of records—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. 27076/41.

CONSERVATOR OF FORESTS (with a University degree in forestry and considerable practical experience), Windward Islands—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27040/74.

DEPUTY DIRECTOR OF AGRICULTURE under the Government of Tripolitania, to be responsible for the administration of the Agriculture Department, including staff, finance, experimental farms, livestock, forestry, and liaison with U.N.O. and Fourth Point personnel—The Ministry of Labour and National Service, Technical and Scientific Register (A.S.12), Almack House, 26 King Street, London, S.W.1, quoting A.12/82/52.

ENGINEER, Post Office Telecommunications Department, British Guiana—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27322/35.

ENGINEER to run a Ministry of Supply machine shop (in the Southern Counties) working to very close limits on highest quality prototype development projects—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting C.215/52A.

ENTOMOLOGIST to conduct the first full-scale research to be undertaken in the Northern Territories of the Gold Coast into entomological factors associated with onchocerciasis and other insect-borne eye diseases—The Secretary, British Empire Society for the Blind, 53 Victoria Street, London, S.W.1.

EXECUTIVE ENGINEER, Electrical and Mechanical Division, Public Works Department, British Guiana—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London S.W.1, quoting No. 27324/11.

EXPERIMENTAL OFFICERS at R.A.F. Signals Experimental Establishments in Bedfordshire and near London: SENIOR EXPERIMENTAL OFFICER (Ref. D.17/52A) for the development of calibration procedure for radio test equipment and preparation of calibration publications, etc.; an EXPERIMENTAL OFFICER (Ref. D.18/52A) and ASSISTANT EXPERIMENTAL OFFICERS (Ref. D.19/52A) for the calibration of standards (*a*) involving frequency and pulse measurements and maintenance of the frequency standard, (*b*) involving bridge and miscellaneous measurements, and (*c*) involving output and attenuation measurements; an EXPERIMENTAL OFFICER (Ref. D.6/52A) for the reconstruction of a radar landing aid and organization of associated experimental investigation, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

FIELD ZOOLOGIST in Kenya, to undertake survey work of tsetse distribution, to make ecological studies of tsetse control and to take part in the general advisory work of the Veterinary Department—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. 27066/12.

MECHANICAL ENGINEERS IN THE PUBLIC WORKS DEPARTMENT, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'M/E Engineer 1813'.

MECHANICAL SUPERINTENDENT IN THE DEPARTMENT OF RURAL WATER DEVELOPMENT, Gold Coast—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. 27325/36.

OBSERVER (with at least second-class honours degree of a Commonwealth university in geology, or in physics with some knowledge of geology, and at least two years postgraduate training or approved experience in scientific research) to take charge of Seismological Recording Stations to be set up in Windward and Leeward Islands—The Under-Secretary of State, Research Department, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

PLANT BREEDER (with a good honours degree in botany, with at least two years postgraduate training or experience in plant breeding) in the Colonial Agricultural Service, Kenya, to assist in work connected with wheat and maize breeding—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27059/13.

PRINCIPAL SCIENTIFIC OFFICERS (electronic engineers or physicists) in the Royal Naval Scientific Service, in the London area and Gloucestershire—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.121/52A.

TECHNICAL ASSISTANT (with a degree in science, technology or engineering of a British university, or an equivalent diploma or national certificate; a knowledge of chemistry at least equivalent to general degree standard is essential), Uganda Mineral Resources (Research) Committee—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. 27079/62/52.

REPORTS and other PUBLICATIONS

(not included in the Monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research: Radio Research Special Report No. 22: The Siting of Direction Finding Stations. By W. Ross and F. Horner. Pp. iv+38. (London: H.M. Stationery Office, 1952.) 1*s.* 6*d.* net. [142

Proceedings of the Royal Irish Academy. Vol. 54, Section A, No. 18: Low Frequency Disturbances in Gaseous Conductors. By E. E. Armstrong, K. G. Emeleus and T. R. Neill. Pp. 291–310+plate 3. 2*s.* 6*d.* Vol. 54, Section A, No. 19: A Study of the Profile of the Hydrogen Hα Line in the Spectra of Solar Prominences. By Mary T. Conway. Pp. 311–320. 1*s.* Vol. 54, Section A, No. 20: Observations of Stellar Scintillation. By H. E. Butler. Pp. 321–340+plates 4–13. 6*s.* Vol. 54, Section A, No. 21: Triangulation in the Hypercircle Method for Plane Problems. By J. L. Synge. Pp. 341–368. 4*s.* 6*d.* (Dublin: Hodges, Figgis and Co., 1951–1952.) [142

Proceedings of the Royal Irish Academy. Vol. 54, Section B, No. 6: An Algal Survey of Lough Foyle, North Ireland. By Helen Blackler. Pp. 97–140+plates 4–6. 5*s.* Vol. 54, Section B, No. 7: The Old Red Sandstone of the Inch and Annascaul District, Co. Kerry. By J. G. Caperwell. Pp. 141–168+plates 7–8. 3*s.* 6*d.* Vol. 54, Section B, No. 8: Movements of Salmon around Ireland. By Arthur E. J. Went. Pp. 169–262. 7*s.* 6*d.* (Dublin: Hodges, Figgis and Co., 1951.) [142

Memoirs of the Geological Survey: England and Wales. The Concealed Coalfield of Yorkshire and Nottinghamshire. By W. Edwards. Third edition. Pp. x+285+5 plates. (London: H.M. Stationery Office, 1951.) 22*s.* 6*d.* net. [142

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Journal of Scientific Instruments. Editor: Dr. H. R. Lang. Vol. 28 and Supplement No. 1, 1951. Pp. xvi+388+iii+80. (London: Institute of Physics, 1951.) [212

British Journal of Applied Physics. Editor: Dr. H. R. Lang. Vol. 2 and Supplement No. 1, 1951. Pp. v+370+viii+96+vi. (London: Institute of Physics, 1951.) [212

Other Countries

Deutsche Akademie der Wissenschaften zu Berlin. Veröffentlichungen des Geodätischen Institutes in Potsdam. Nr. 1: Fehlertheorie und Ausgleichung von Rautenketten in der Nadirtriangulation. Von Karl Reicheneder. Pp. viii+98. 11 D. marks. Nr. 2: Der 24m-Interferenzkomparator des Geodätischen Institutes in Potsdam. Von F. Mühlig. Pp. iv+50+1 plate. 7 D. marks. Nr. 3: Ergebnisse der Pendelmessungen der Jahre 1934 bis 1943. Zusammengestellt von K. Weiken. Pp. 32. 9 D. marks. Nr. 4: 1. Die vollständige Bestimmung örtlicher gravimetrischer Störungsfelder aus Drehwaagemessungen mit Berechnungsbeispiel (Messtischblatt Weddingstedt i. Holstein). ii. Das physikalische Bildungsgesetz der Figur der Erde (Theorie der normalen Erdgestalt). Von Hans Haalck. Pp. vi+53. 13 D. marks. Nr. 5: Geometrischanschauliche Auflösung linearer mit Nullkoeffizienten ausgestatteter Gleichungssystem. Von Konrad Friedrich und Werner Jenne. Pp. viii+68. 6. D. marks. Nr. 6: Nadirketten mit Streckenmessung (Aeropolygonierung). Von Karl Reicheneder. Pp. v+41. 4 D. marks. (Berlin: Akademie-Verlag, 1949–1951.) [62

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Smithsonian Institution: Bureau of American Ethnology. Bulletin 149: Symposium on Local Diversity in Iroquois Culture. Edited by William N. Fenton. Pp. v+187. (Washington, D.C.: Government Printing Office, 1951.) 75 cents. [132

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